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ORIGINAL ARTICLES.

THE PLANET MARS.

By John Phillips, M.A., Oxon.; LL.D., Dublin; F.R.S.

The ideas formed of the heavenly bodies and the spaces in which they move, or seem to move, change from age to age, with the improvement of the means of observation, and from region to region, according to clearness of sky, advantageous situation, and favourable climate. Among all people, and in every age, the two great lights of heaven, the giver of day and the ruler of night, have been honoured, if not worshipped, as glorious emblems of the infinite power which governs the phases of Nature, "constant in her ceaseless change." The "starry host," contemplated by shepherds who watched their flocks by night on the plains of the East, very soon parted itself into the lights which seemed to be fixed and immovable in the blue revolving dome, and the "planets," or wanderers, which moved among the rest, and sometimes retraced their steps. To these also, as emblems of a guiding power, honour and worship were addressed; sacred names were given to them—days were named after them; and our Christian week preserves the titles of an earlier and alien creed.

The early Greek pilot who lifted anchor and set sail in the evening—as when Odysseus quits the shores of Phæacia, or his son leaves Ithaca for the mainland—turned for guidance to the stars which circled round the pole. Sitting sleepless by the rudder he observed the Pleiads and Bootes late sinking in the west, and the Bear who, continually revolving, watches Orion, without ever touching the sea.* The five planets observed were soon distinguished into those of longer and shorter periods; Saturn, Jupiter, Mars, Venus, Mercury; and to them the mystical relation was adapted which represented the slowest of the planets as the oldest and dullest, and gave to the quickest the name of the youngest and most sprightly, and dedicated the "fairest of stars" to the goddess of beauty. Looking back on these memorial names, and the ideas connected with them, from our present standpoint of augmented knowledge and lessened reverence, it is easy to believe that among the bards of antiquity, as among the poets of our own time, the standard of astronomical knowledge was below the philosophic level of their age. Yet Lucretius shows no such confusion of thought as occurs in the glittering verses of Pope, who transforms the simple Homeric simile—

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* 'Odyssey,' lib. v. 271.

> "—— as when in heaven the stars
> Around the shining moon look beautiful;"[*]

into the gaudy—

> "Around her throne the vivid *planets* roll
> And stars unnumbered gild the glowing pole."

Coming to modern times, when the Earth took her place in astronomical systems as one of the planets moving round a central sun, the idea of a common origin for the whole manifests itself in different ways: one general direction of their motions nearly in one general plane; one law of their periods; analogies of figure, of rotation, of borrowed light, of attendant satellites; all concurred to justify the supposition of the planets possessing one common character of constitution, adaptation, and use. Not that those ideas of common origin and similar composition are to be found clearly traced out by the immediate followers of Copernicus, though Kepler furnished the planets with inhabitants, and Brunus and Cusanus allowed the sun and fixed stars theirs too. Not even among the contemporaries of Newton was there enough of acquired knowledge in regard to many of the phenomena to suggest a really general speculation as to the beginning of the solar system. The argument from analogy and the fitness of things, was indeed strongly felt and strongly urged in the seventeenth century, so that, to take no other example, Christian Huygens, writing to his brother Constantine, said:—"A man that is of Copernicus's opinion, that this earth of ours is a planet carried round and enlightened by the sun, like the rest of the planets, cannot but sometimes think that it's not improbable that the rest of the planets have their dress and furniture, and perhaps their inhabitants too, as well as this earth of ours, especially if he considers the later discoveries made in the heavens since Copernicus's time, *viz.* the attendants of Jupiter and Saturn, and the champaign and hilly countries of the moon, which are a strong argument of a relation and kin between our earth and them, as well as a proof of the truth of that system."[†]

Huygens, it is well known, bestowed great attention on Saturn and his rich retinue of rings and moons. Speaking of Cassini's observations with long telescopes, by which the inner satellites of that system were discovered, he in some degree anticipates by nearly a century the thoughts of Bode and Olbers, when declaring his expectation that by reason of the "disproportionately large distance" between the fourth and fifth satellites, a sixth might be expected there. Bode's law, dating from 1772, does, indeed, place in strong light the simple numerical proportions which prevail among the planetary spaces; and Olbers's discovery of the first of the small planets which occupy the interval between Mars and Jupiter, and thus confirm the law, adds much to the analogies which are the usual basis for the conviction now so general of the common origin of all parts of the solar system. What that common origin was has been sketched for us on quite opposite plans by two eminent Frenchmen, Buffon and Laplace.

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[*] 'Ως δ' δτ' εν ουρανῷ αστρα φαεινην αμφι σεληνην—φαινετ' αριπρεπεα.

[†] 'Celestial Worlds,' Ed. ii. English translation, 1722. The work was first issued after the death of the author in 1684.

In the mind of the Count de Buffon, such a speculation assumed a singular form. The matter of the planets was projected from the sun by the shock of a comet. It was quite fluid, and gathered by attraction, into globes rotating on their axes. In some cases, the rapid rotation of planets while still fluid, caused parts to separate and to collect into smaller globes, which circulated round the planets, as these revolved round the sun. During the cooling, which Buffon seems to have thought was pretty quick, the solid, liquid, and gaseous matters were separated, and took their places according to gravity. Most of the leading harmonies of the solar system are left unexplained, others contradicted by this hypothesis.

Laplace, who has honoured the scheme of Buffon by a notice of its inherent defects, attempted to rise to the true theory on sounder principles. He proposed what is now called the Nebular Hypothesis, on the fundamental idea of an original expansion by heat of all the substance of the planets into a vast atmosphere round the sun. Revolving round the sun, and subject to continual contraction by cooling, the external sheaths of this atmosphere would be left behind to continue their acquired movements, and finally to collapse into globes, rotating and revolving according to the one original direction. In a general sense, we may say the main facts of the solar system are not opposed to this speculation. The small excentricity of planetary orbits; their common direction of motion; the greater velocity of the inner planets; the various directions and great excentricity of comets; the zodiacal light; the nebulæ, which actually exist in a variety of forms; and, finally, the agreement of all the planets in their borrowed light, their spheroidal figures acquired by revolution, the presence of atmospheres, and the limited range of their densities—the larger planets being, in general, least dense—all these circumstances are apparently in harmony with this, the only general speculation at all supported by mathematicians and astronomers. To change it into an established theory by comparing it strictly with special phenomena of the solar system, such as the inclinations of the axes of planets, the order of their densities, the velocity of their rotations, the peculiarities of their satellites, has been hardly attempted, except in respect of the equality of the mean motions of rotation and revolution of the moon and other satellites, by Professor Haughton.* This remarkable adjustment appears not to be explained by the hypothesis, but not to offer a positive contradiction to it.

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* 'Trans. R. I. Academy.'

The orbit of Mars is more excentric than that of any of the other planets except Mercury: his distance from the sun varies from about 154 to about 130 millions of miles, the mean being about 140 millions. The earth being about 93 millions from the sun, the interval between us and Mars varies from about 40 millions at the least to about 240 at the most. The apparent magnitude of the planet as seen from the earth is sometimes as little as four seconds of space, and sometimes as great as twenty-two seconds.

When Mars is in opposition, that is to say, on the same side of the sun, and nearly in the same straight line as the earth, the best opportunity is afforded for telescopic observation. Mars revolves round the sun in 687 days, the earth in 365; consequently once in two years and seven weeks, roughly speaking, Mars is in opposition. As the points of opposition thus circle round the ecliptic, the declinations of the planet vary. Thus oppositions are more or less favourable, as the distance of Mars is less and his declination more to the northward. In 1862 Mars was in opposition on the 9th of October, in 1864 on the 30th of November; in the former case he was nearer to us, and had a visible diameter of 22″; in the latter he was farther off, having only a diameter of 16″, but his declination was more to the northward, and on this account he was well seen.

No occasion so favourable for observing the planet in opposition has occurred since 1836, or will occur again for twelve or fourteen years to come; but every opportunity should be seized of watching every change of appearance; for by reason of the considerable angle between the equator of Mars and the plane of his orbit, the planet is presented in various aspects; at one time the north pole, at another the south pole is more visible, while at particular epochs the axis is at right angles to the line of sight. Hence the extremely diverse and at first view perplexing appearances, which have been faithfully portrayed by Mädler, Herschel, De la Rue, and other observers.

The telescopes employed by Galileo were powerful enough to detect the phases of Mars; those in the hands of his successors revealed the more considerable spots. Hooke and Campanus were among the first to observe them, and Cassini, as might be expected from so great an astronomer, employed them in determining the daily period of rotation, which he found to be a little longer than that of the earth, *viz.* 24h. 40m., a result which differs (by excess) only 2m. 38s. from the period now generally recognized. Cassini's nephew, Maraldi, repeated these observations in 1704, and found the rotation to be 24h. 39m.; Herschel in 1784 assigned to this same period 24h. 39m. 21s.·67. These nearly agreeing determinations assure us, among other things, of the goodness of the long refractors employed in the seventeenth century before the introduction of achromatic telescopes. By observations of the same kind the inclination of the axis of the planet to the plane of its orbit is ascertained to be about 61° 18′, or, to use the ordinary expression, the obliquity of his ecliptic is 28° 42′. This ecliptic of Mars is oblique to the earth's orbit, 1° 51′. When in

1862 the opposition of Mars drew near, one of the first objects, with many observers, was to estimate the difference of his polar and equatorial diameters, in fact, to measure his ellipticity. The compression due to his rotation is very small, not greater than that of the earth, about $\frac{1}{300}$th. Now as the diameter of Mars is about 4,000 miles, and the difference of the diameters would be about 13 miles, and as the apparent diameter of the planet was nearly 22″, it is obvious that the compression would be $\frac{22}{300}$ or $\frac{1}{14}$ of a second; a quantity too small to be observable with certainty by any but the finest instruments. Our observations with the ordinary position micrometer failed to determine any sure difference of the diameters; and this is perhaps the most general conclusion of other late observers. Yet there is the high authority of Mr. Main, and a large discussion of measures with the famous Oxford heliometer for assuming the compression to be not less than $\frac{1}{37}$th. Arago had previously stated it at $\frac{1}{39}$th. Herschel indeed stated it at $\frac{1}{16}$th, but this was probably some accidental error. At the time of the opposition, the south pole of Mars was visible from the earth, the axis being then tilted toward the observer about 25½.

Around this south pole there was seen a coronet of bright, nay, splendid and glittering snow, elliptical in figure, and rather unsymmetrical to the axis. This mass of snow had been observed by Lord Rosse in July, three months before the opposition, and was then estimated to have a diameter of 1,000 miles; at the beginning of the opposition in October it was estimated again not to exceed 560 miles; it diminished sensibly and continually during two months of observation. The north pole was not visible, nor was any snow positively remarked in that region by any observer.

From this it appears that snows which surrounded the south pole to a distance of 16 degrees or to S. lat. 74° in the month of July, had retreated to about 8° or S. lat. 82° in the month of October, the pole having been all that time in sunshine. In 1864 the opposition was later in the year by about seven weeks (end of November). The south pole was tilted towards the observer only about 6°, and the snows had undergone the longer action of the sunshine. Accordingly it was only a very small ellipse of snow which could be detected, and that not always by the most careful observer round that only just visible pole.

On the other hand there were sure indications of snows in two situations very brilliant and prominent on the northern surfaces whose places, as represented on a drawing, have been transferred to the accompanying chart. These northern snows then appeared to reach a latitude of about 50°, and to constitute an interrupted arctic zone in the latter part of the south Martial summer, and towards the close of the north Martial winter. At this epoch then, not less than 50° of northern latitude were free from at least great tracts of snow, a result which fairly matches the average climate of the northern zones of the earth towards the end of our winter quarter in the month of February. In April, 1856, a careful drawing made by De la Rue,* represents two snow masses, seen contemporaneously, one extended far around, or rather in one direction from the south pole, the other near, but not at the north pole, which was then presented to the sun. The snows near the south pole must then have reached to the 40th degree south latitude along one meridian. The interval between the snow of the north and the south appears to have been about 105°; while this interval on the earth may be taken at 120°, so that the temperature of the surface of Mars is not much lower than that of the earth, and perhaps is not subject to such extremes of heat and cold, though this could hardly be expected, since its revolution period is longer and its ecliptic more oblique than in the earth. The surface of Mars, which is generally free from snow, offers a great variety of distinct outline, which separates bright parts from dusky or shady parts. In general a very distinct, undulated outline of this kind can be traced along the intertropical regions mostly south of the equator, from which a large tract of bright surface spreads towards the north, while towards the south for the most part, the surface is either distinctly greenish grey, or appears in half lighted spaces, with less defined outlines than that already referred to. Calling the grey parts sea, and the bright parts land, the first impression on looking at Mars would generally be that water prevails in the southern, and land in the northern hemisphere. The land where broadest has a soft reddish tint, which resembles the hue common in low "cumulus" clouds in the morning and evening hours, or the diffused air tints in a foggy sunset.* Faint Indian red is a good imitation. This colour of the surface fades away in mere brightness towards the main southern boundary already referred to, and is hardly to be traced at all over any part of the smaller, and less distinctly bordered lands to the south. The white brightness of the land along the main boundary is occasionally so great, as in the meridian of 360°, as to suggest at first the idea of snows, but a careful inspection removes this impression. The brightness is in some degree enhanced in its effect on the eye, by the dark spaces which lie in the grey tracts on the south side of the boundary. This is observable in several parts, as represented in the chart, one broad dark surface appearing about the equator in long. 20°, and thence spreading with ramifications to the southward, and extending down a narrow channel (180 miles wide) towards the north polar region, which is apparently for the most part a watery surface; excepting these instances the dusky spaces are not strongly marked; nor, except in broad surfaces, is the greenish hue remarkable. Indeed, during the opposition of 1862, several observers with achromatics did not notice either the reddish tint of the land, or the greenish tint of the water, but both were always seen when reflectors were used.

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* See 'Quarterly Journal of Science,' No. vi. p. 232.

It may now be fairly asked, whether the tracts of bright white surface called snows are such; the ruddy and bright surfaces really land; the grey shady spaces actually sea? Whether all the lighter tracts be, in fact, anything more than the appearances naturally arising from vast and diversified clouds shining above a dark surface, such as the brighter belts of Jupiter are thought to be?

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* Huygens noticed this and thought the land in Mars to be of "a blacker colour than that of Jupiter or the moon, which is the reason of his appearing of a copper colour and his reflecting a weaker light than is proportional to his distance from the sun."

In answer to this, it is to be remarked, that in respect of the snow there is proof of its gathering in the winter, and melting away during the summer and autumn; distinctly melting away almost under the eyes of Lord Rosse, Mr. Nasmyth, and others possessed of fine telescopes. There must then be watery surfaces, and an atmosphere capable of transporting vapour from one side of the globe of Mars to the other. Either the grey or the ruddy surfaces must be water. We can have little doubt which. Water must necessarily show much more obscure than the land, as any one may satisfy himself, who from a very high mountain will but look down upon the earth.* The white and reddish parts must then be land, and we are the more assured of this when we perceive it is over these parts the snow appears to spread far from the poles in the wintry seasons. Another doubt which may be felt as to the certainty of the boundaries drawn between the land and sea deserves careful attention.

For if we admit a vaporous atmosphere to Mars, how can we be sure of clear spaces in this envelope through which to behold—

> "Oceans or mountains on the spotty globe?"

The true answer appears to be that we are really looking through an atmosphere partly clouded, as the earth's atmosphere is, and yet that this does not prevent our tracing the true boundaries of the land and sea if we observe often enough and compare the observations of different persons, made at different times, and under different aspects of the planet. It may sometimes confuse particular parts—some parts more especially and more frequently, perhaps—but on the whole there is no reason to expect more than this effect. For if we consider the spaces occupied by the clouds above the earth, we shall be sure that at any one moment of time the greater part of our sea coasts would be traceable by light and shade, while over some tracts vapours would hang in patches, and above others they would spread so as quite to conceal the surface of the land and sea. Even in this last assumed case of a wide-spread cloudiness, the observations of one day or week may be amended on another occasion. This, in fact, has been noticed by several observers, and one case in particular may be quoted. On our chart, in long. 45° and north lat. 15°, is the end of a sort of inlet from the great Meridional strait, which was seen in 1862 by Mr. Lockyer, and by Mr. Dawes in 1864. I did not see it on either occasion, nor did Mr. Lockyer see it always; yet it was seen by Mädler in 1836, and it must be admitted as a real feature in the hydrography. One second of angle included a space of about 180 miles on Mars during the former opposition, and 240 miles in the latter. If we grant that the eye could distinguish spaces to the minuteness of $\frac{1}{10}$ of a second, and that we were looking through a partially clouded atmosphere, it is almost certain that in general the cloudy spaces would not be distinguished as such, except by the general weakening of the distinctness of the outline between land and sea, which yet would remain traceable in all its main features. This effect has been occasionally experienced by every observer of Mars; never by any observer of the moon. Perhaps it is to some effect of this kind that the comparative indistinctness of the outlines, and indeed uncertainty as to the separation of the masses of land and water in the southern parts of the planet, is to be ascribed.

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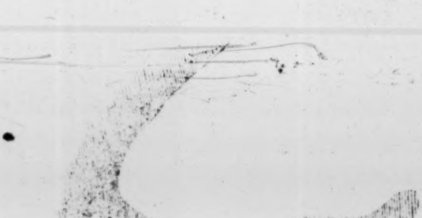
* Huygens' 'Celestial Worlds.'

This uncertainty has been felt most in regard to the tracts of half-lighted land spreading southward between longitudes 240° and 350°; tracts which in our drawing are partially shaded, to imply some remaining doubt as to their being really land. A similar method has been followed in regard to the extended tract about long. 90°, 120°, and 150°, and lat. 40° south. In some drawings from Lord Rosse's telescope, in 1862, examples of extremely different aspects of the same part of the surface appear. About the central longitudes in the chart on the 22nd July, 1862, a very broad belt of light and shade swept excentrically round the south pole; the same tract, on November 6th, more resembled a very large network, and on the 6th of October it was still quite different, but resembled a drawing of Mr. Lockyer's, taken October 3rd. From the same great telescope, also, two drawings were made on the 16th September and 29th October, which differ much from each other, and from a drawing by Mr. Lockyer, 17th September, in the space south of the equator, about longitude 240°-280°. One of these drawings, September 16th, suggests, by its half-circular lights and shades, the idea of a vast cyclonic movement. A kind of enormous spirality also occurs in Mr. Lockyer's sketches for October 3rd, suggestive more of atmospheric vicissitude than terrestrial feature.

Adopting this idea of a great change of appearance over particular tracts due to atmospheric variations, we shall find the diversity of aspect from day to day between one observer and another, and between one telescope and another, less perplexing.

A remarkable dark spot on the equator, in long. 300° of our chart, was observed by Mädler, and has been often seen by other and later observers. It appears sometimes detached, as in our chart; at other times, connected with the long dark gulf, which extends to long. 360°. The whole of this gulf is found to change appearances in detail, yet not so as to render in the least degree doubtful the recognition of its main features. The sketches opposite will illustrate this:



On the whole then, the circumstances already collected regarding the physical aspect of Mars appear to justify the conclusion, that the planet has a larger proportion of land than water, in this respect differing from the earth, and that the land is mostly collected in a broad band, including the intertropical spaces, and the north temperate region, ~~while b~~road seas encircle the north pole and a large proportion of the south temperate zone. In this last-mentioned large space, the appearances vary much, and in such a manner, as to indicate the overspreading of clouds, which reflect much light, and leave visible between their vaporous masses, the darker surface of the sea. Some particular limited tracts, of sea channel apparently, much darker than the rest of the surface, may, perhaps, derive this hue from greater depth of water. We are thus placed by telescopic observation in front of a planet, whose main characters of surface correspond to those of our earth; which has nearly the same density; nearly the same daily and nightly period; and is enveloped like our earth, by an atmosphere partially loaded with scattered clouds. It has also a character of climate not much different from the more continental parts of our globe, with which, on account of the excess of land over water in Mars it may be most fairly compared. How is this character of climate obtained by Mars, while the mean quantity of sunshine falling on any particular tract is only $(\frac{100}{152})^2$ of that which reaches and warms the earth? Only two suppositions can be at all worthy consideration: the flow of heat from the interior of Mars may be greater than in the earth, and the waste of heat from the surface may be much less. These may co-exist; but the most important, beyond any doubt, is the second. The waste of heat from the earth's surface would be enormously greater, and very much more rapid, than it is, but for the atmosphere, which acts in two ways to prevent it. First, it acts like a coating to a steam-pipe—the more of it the greater the effect. A greater depth of atmosphere round the earth would keep it very much warmer. If we suppose the effect to be proportional to the density (or pressure), then twice as deep an atmosphere as that which exists round the earth would sensibly raise the temperature, and in the same way the same effect would be produced in Mars. Again, the atmosphere has a specific action of this kind—it permits the solar light and heat to pass to the earth, yet by reason of its peculiar constitution, especially by the aqueous vapour and watery particles suspended in it, obstructs the radiation of heat from the earth. If, then, we suppose the atmosphere of Mars to be deeper than that of the earth, the waste of heat will be less.* It cannot contain more aqueous vapour, in proportion, than the earth, unless there be warmer oceans on Mars, for its marine area is less; but with a greater depth of atmosphere the

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* "If we allow to Mars an atmosphere similar to that of the earth, but of greater thickness, to the amount of some 15,000 or 20,000 feet, the mean temperature may be 60° Fahr. at the equator and about 14° or 15° Fahr. at the pole, supposing the additional atmosphere to have rather less effect at the pole than at the equator."—*Hopkins in 'Camb. Phil. Trans.'* 1855, p. 663.

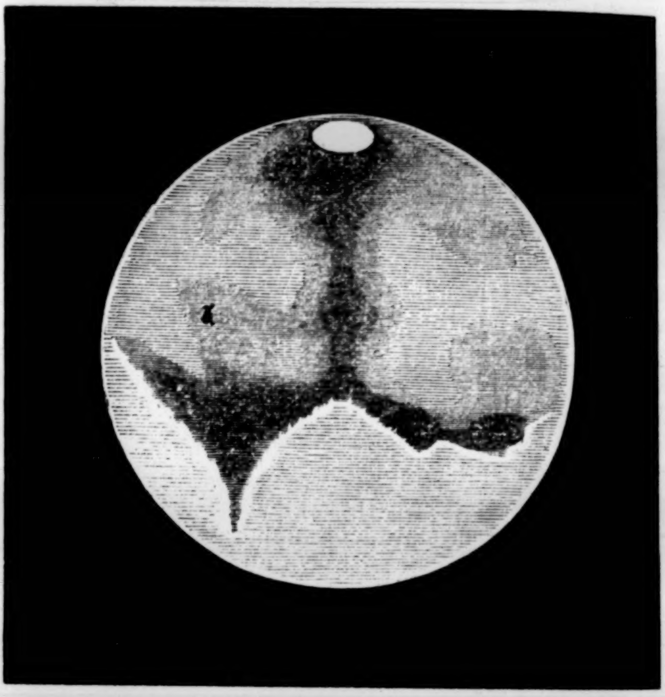

FIG. 1.—Mars as seen on the 27th of September, 1862, and on several other occasions till the 13th December. Longitude 0°.

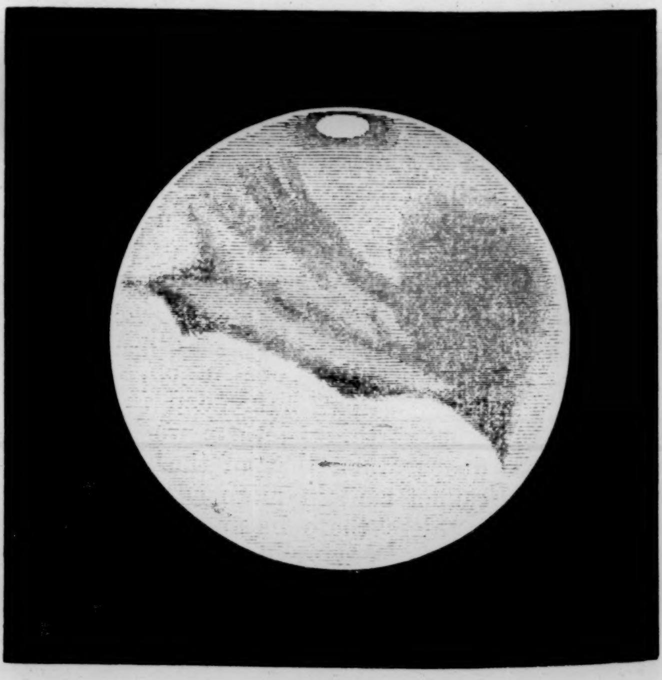

FIG. 2.—The appearance of Mars at longitude 90° with long oblique ridges south of the great boundary and nearly or quite running into the northern band: here less broad than in Fig. 3. Seen November 11th, 1832.

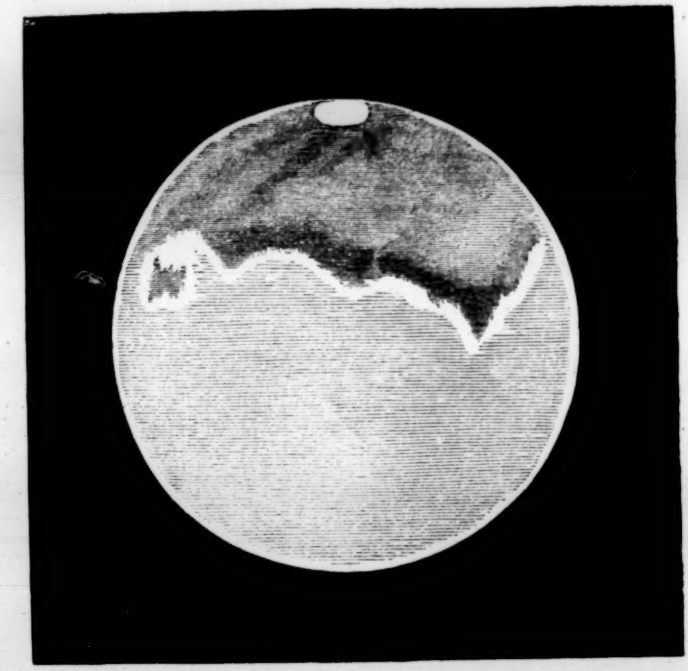

FIG. 3.—The hemisphere of Mars opposite to Fig. 1. Seen October 15th and 16th with a specially dark band.

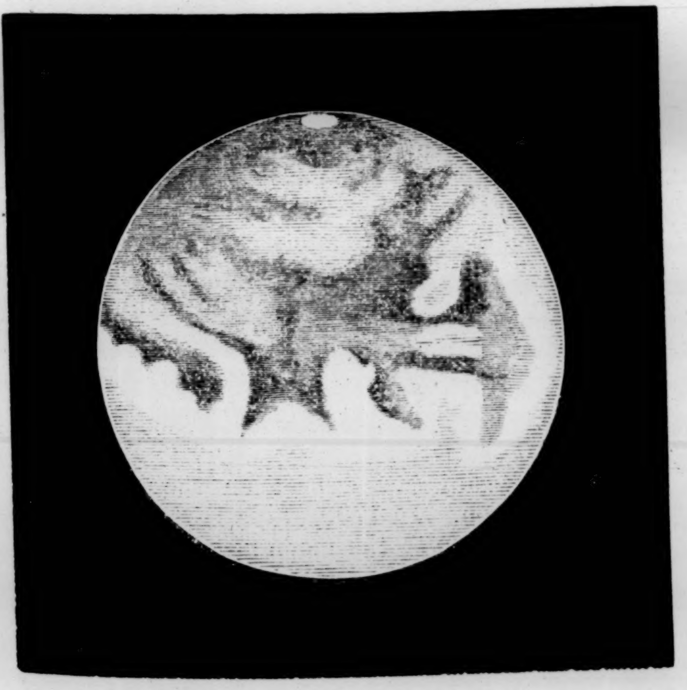

FIG. 4.—The hemisphere of Mars opposite to Fig. 2. September 23rd, 1862.

effect of the vapour in arresting the outflow of heat may be greater. It is possible, however, that his atmosphere may be peculiar in quality, and may contain elements more capable of resisting the waste of heat than exist on ours. And these may not be beyond the ken of spectral analysis. So that without any unlikely suppositions we are provided with a fair explanation of the comparatively mild climate of Mars, and may expect from further research sure measures of the extent of his atmosphere, and certain knowledge of its constitution and action on radiant heat. If we could be quite confident of the exactness of some observations of Cassini and Rœmer, on the dimness and almost extinction of stars before and after occultation by Mars, we should have no doubt of his being surrounded by an extensive and partly cloudy atmosphere; but Sir J. South found no such obscuration, and concluded that either some physical change has occurred in the atmospere of that planet, or that the observations of Cassini were inaccurate. Perhaps the safe conclusion may be that the atmosphere exists, but is not always loaded with clouds, and this is in harmony with all that appears on other grounds to be likely.*

The greater our knowledge of the true constitution of Mars, the better chance have we of ascertaining the physical peculiarities of the other planets. We must not expect discoveries on them to proceed at so great a rate as on Mars. Mercury is too near the sun to be well seen. Uranus and Neptune too far from the earth. Of these planets, even the rotation period is not ascertained. Schröter, indeed, not only speaks of spots on Mercury, but gives measures of mountains rising above his surface, one more than one mile, and another nearly eleven miles, and assigns a rotation period of 24h. 5m. 28s. But in this, and in other statements, he is quite unsupported.

No great amount of definite knowledge is acquired regarding the surface of Venus or Saturn, though for these the rotation period has been assigned by means of some shadowy parts, whose recurrence has been observed, but not by modern instruments.

To Huygens, looking through a telescope 45 or 60 feet long, Venus appeared "all over equally lucid, without so much as one spot in her;" and after satisfying himself that no distinction of land and water could be traced in her, he asks, "Is not all that light we see reflected from an atmosphere surrounding Venus, which, being thicker and more solid than that in Mars or Jupiter, hinders our seeing anything of the globe itself, and is at the same time capable of sending back the rays that it receives from the sun."†

Yet in 1666, Cassini saw a spot on the edge like a bright prominence on the moon. In 1700, De la Hire discovered mountains in Venus larger than those of the moon; and Schröter not only saw mountains, but measured them.‡ Four of these were found to be elevated from 10 to 22 miles. Modern observers have not confirmed these statements; yet, during the present year, we have seen such

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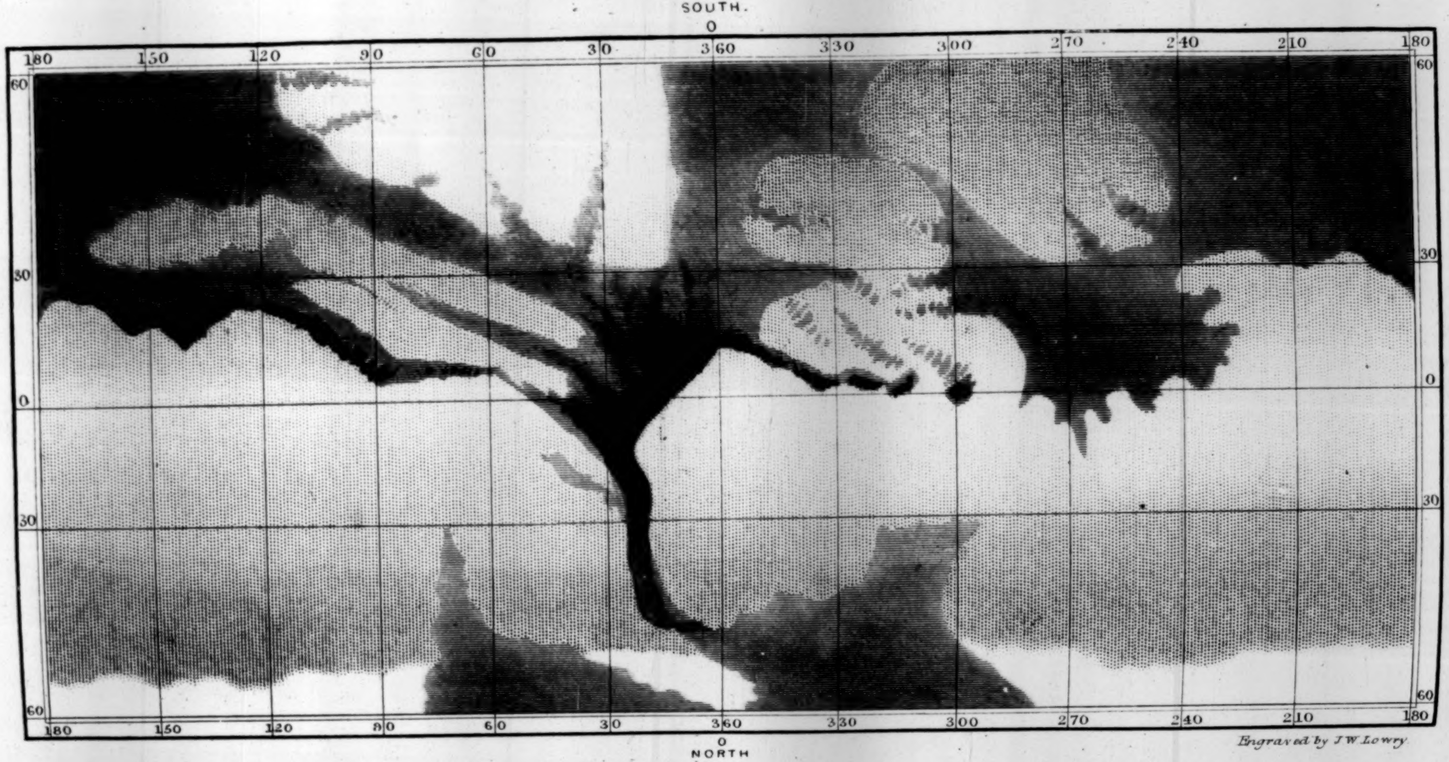
* 'Proceedings of the Royal Society,' 1831, 1832.

† 'Cosmotheoros,' first published 1684.

‡ 'Phil. Trans.' 1792.

Chart of the Planet Mars.

By Professor Phillips.



This Chart is founded on the observations made in 1862, separately, by Mr. J. N. Lockyer, and Prof. Phillips; repeated in 1864 by Prof. Phillips. Drawings made in 1862 by Mr. Main, and in 1864 by Mr. Dawes, have also been consulted. For the Northern circumpolar regions, and extent of southern snows, the engravings of Mr. De la Rue & Padre Secchi have been employed. The earlier

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differences in the distribution of partial light and shade on Venus, before sunset, as to give some reason for hope that it was not all cloud-land which was surveyed with the long telescopes of Cassini.

The rotation period of Venus was given by Cassini at 23h. 16m., and by Schröter at 23h. 15m.

Of the surface of Saturn, we have, chiefly, belts like those of Jupiter, but not so clearly defined; some spots from which the rotation has been computed at 10h. 16m., and some variable appearances about the poles which indicate atmospheric changes; for we dare not speak of polar snows in so distant a planet.

The observations on Jupiter, in some degree intermediate in character and in distinctness between those of Mars and those of Saturn, help to confirm the now general belief in the common origin and agreeing nature of all the planets. For here spots of a definite shape and place are traceable in the dark spaces between the bright belts; the belts are seen to change in extent and outline; they vary even in number, and are constant only in the direction parallel to rotation, and in the colour, which is that of cloud reddened by morning or afternoon sunshine, and this not equally in every part. The rotation is accomplished in 9h. 56m. This prodigious velocity, about 30,000 miles an hour at the surface, would have occasioned heavy cyclonic storms, and violent winds from the north-east and south-west, but for the nearly perpendicular position of the axis of the planet to the plane of the orbit—a circumstance also observed in Saturn, and productive of the same regular atmospheric currents.

ON THE PREDISPOSING CAUSES OF PESTILENCE.

There are many persons to whom the existence of disease is the most mysterious and inscrutable problem in Nature; who regard it as a phenomenon the most difficult to reconcile with the wise government of an all-merciful Deity. Such persons, along with others who do not trouble themselves to think at all, regard the advent of a pestilence with superstitious fear, as did their ancestors, considering it to be a scourge sent to punish man for his spiritual backslidings; his sinfulness often consisting, in their eyes, of a disbelief in, or neglect of, their particular views of salvation. Those, on the other hand, who are often derisively called optimists, look upon physical maladies as civilizing influences, having their origin in the neglect, not of spiritual but of moral and physical laws; and although they, too, fear the approach of a plague, it fails to awaken in them a superstitious and inexplicable dread, but calls forth renewed activity in the work of sanitary reform. A more pressing duty prevents us from entering further upon the philosophical consideration of the subject, but it will be found that what has been said of the present applies also to the past, and that the nature and predisposing causes of disease have always been similar to those which prevail in our time.

Whilst we are writing, the tidings reach our shores that a fearful epidemic is committing ravages in Russia, and anxious voices are raised in our deliberative assemblies inquiring into the nature of the plague, and whether it is likely to reach our sea-girt isle.

The nature of the disease is not clearly defined, but those who are the best acquainted with modern forms of epidemic maladies, pronounce it to be typhus and relapsing fever. In olden times, and even at present, in Eastern countries, this "formidable complication of typhus fever" was accompanied by "carbuncles" and "pestilential buboes," and the Russian epidemic, which is also characterized by these symptoms, is believed by the authority we are quoting* to be the modern form of the ancient plague. Not only, however, have these concomitant symptoms been found to present themselves in the Russian typhus, but inquiries have led to the ascertainment of the fact, that they are also sometimes present in the English form of the disease, which has been very prevalent of late years, and that not less than 150 cases of typhus in the London Fever Hospital have, during the last three years, been accompanied by these inflammatory swellings. The same excellent authority tells us that the Continental epidemic is almost entirely confined to the poorer classes; that it arises partly from a want of sufficient nourishment, and that its virulence and alarming spread are due to the fact that thousands of labourers are flocking into the large cities, overcrowding the pauper population to an inordinate degree; and thus "as this crowding increases, the fever which results from crowding (typhus) is gradually superadded to that which is more immediately the result of destitution (relapsing fever)." The same disease (typhus), we are further told, is also confined to the poorer classes here, and to clergymen and medical men who come in contact with them, and we need therefore not apprehend "the importation of the Russian epidemic." We confess our inability to appreciate the full force of this reasoning, which appears to be that as the worst form of the disease already exists in England, we need not apprehend its extension through the importation of the milder phase, but we must give the writer of the article from which we have quoted the benefit of the most important lesson that it inculcates, namely, that "we should not allow the Russian epidemic to create a panic, by encouraging the popular fear as to the invasion of these shores by a new disease," but "should endeavour to expel an unwelcome guest which for years has been spreading, far and wide, misery and death, but which with proper precautions ought no longer to exist amongst us."

But, we shall be asked, "What precautions are here referred to? What are the causes of the existence in England of a plague, the full danger of which is not made manifest until we hear of its raging abroad, and threatening to become more virulent through an imported accession of strength? Are, then, the conditions in which the poorer classes live in our own country *chronically* the same as those which have temporarily ignited this pestilential conflagration in large

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* 'The Lancet.'

Russian cities; and is it indeed true that the best of men, those who labour to preserve our bodily and mental health, our medical and clerical brethren, walk daily in the haunts of disease and death, and that they are the only victims in the 'middle classes,' of the pestilence which is constantly decimating the lowest orders?"

These are the inquiries which we are bound to answer, and the following observations must serve as the replies.

If our readers were abruptly told that there are to be found *anywhere* in the present day thousands of human beings who live herded together so as to render the exercise of social and moral influences impossible, and in such a manner as to induce every form of vice, misery, and disease; that the air requisite for normal and healthy respiration in one individual is often distributed to a whole family by whom it is again and again inhaled along with their united exhalations; and that there are poor creatures who have become so completely habituated to this noxious state of existence as to dread the exposure to healthier surrounding influences whereby their old habits and associations would be broken or interfered with; they would regard the statements as exaggerated, or would imagine that they referred to the inhabitants of some African village, or to the snow-huts of the Esquimaux. But when we add that it is not in savage life, where Nature continues to some extent to maintain the sway whereby she keeps the lower animals healthy and unpolluted, that these abominations exist; but that it is in the very centres of civilization of the two foremost nations in the world, in the large cities of Great Britain and France, then we shall expect to be called upon for evidence in proof of our assertions. This we are unfortunately but too well able to afford, but before calling our witnesses we would add that not alone is the wretched mode of existence a misery to the poor creatures who are subjected to its influences, and fatal to those who are compelled by their avocations to visit and associate with them, but it spreads havoc and desolation around amongst the wealthy and intelligent, singling out its victims indiscriminately; here a son or daughter, there a father or a mother, and consigning them to an early grave; and thus illustrating the principle that no section of society can commit a breach of moral or physical law, without the whole being more or less involved in the punishment.

It is about twenty or twenty-five years since the governing bodies of the State and the municipalities of our large towns had their attention drawn to the mine upon which the people reposed in fancied security, a mine which was now and then sprung to the astonishment and horror of the ignorant, who could not understand that the combustibles were constantly accumulating below and only needed the spark to produce an explosion, but who looked upon the recurrent epidemic, pestilence, or plague, as an unwelcome visitor from foreign parts. The startling announcements of the inherent danger were made by a few individuals, whose official position had rendered them familiar with its existence, and the late Dr. W. H. Duncan, medical officer of the Liverpool Health Committee, was one of the most prominent of these benefactors of the people. He ascertained that 20,168 of the inhabitants of Liverpool dwelt in 6,294 cellars, many of them damp, close, and totally unfit to be used as human habitations.* Also, that a very large proportion of the population lived (and for that matter *still* live) in courts, of which many were closed at one end so as to preclude ventilation, and some were almost, if not entirely, unprovided with conveniences for the deposition and removal of effete substances. On investigating closely the relation between these horrible dens and the ratio of disease in the town of Liverpool (which has still, we believe, the unenviable reputation of being, notwithstanding its natural advantages, the most unhealthy town in the three kingdoms), Dr. Duncan found that "the proportion of damp and wet cellars is greatest and least in the same districts where fever reaches its maximum and minimum;"† that the prevalence of fever in the different districts of Liverpool bears a general relation to the character of the courts, the state of the sewerage, and the density of population in each district,‡ and that these unhealthy conditions of existence in courts and cellars were well known, and had been reported upon *as far back as the year* 1802,§ but that they had been allowed to remain through nearly half a century, because "*inferior considerations triumphed over the public good.*"

Thus we find at the outset that, within the memory of many who are still alive, there existed in the leading seaport of Great Britain a state of things worthy of some native African village, or subterranean Arctic hovel, but extremely disgraceful to any civilized community; and we are forced to add, that when Dr. Duncan's report of 1843 is compared with that of the present excellent medical officer for the same town, published in 1865, we find that, although every effort is being made to mitigate the old evils, many of them still exist to an extent that would be incredible were they not presented to us accompanied with names, places, and every detail to assure us of their presence.

Leaving their consideration for awhile, we will direct our attention for a moment to another great commercial centre, the trading capital of Scotland, and in Glasgow we find that twenty years after the date of Dr. Duncan's report, namely in 1863, the poorest inhabitants were still in the same dreadful condition, and dragged out their wretched lives under similar circumstances to those recorded of the poor of Liverpool in 1843.

Dr. Gairdner, the medical officer of health for the City of Glasgow, says:‖—

"From inquiries made of one of the best informed district inspectors of the poor, I am quite satisfied that many fever cases, even in the worst possible sanitary circumstances, in the most over-crowded houses, in the midst of neglect, filth, and wretchedness, are not, and some of these cannot be, removed to the infirmary. I am equally well satisfied that so long as this is so, and so long as healthy persons are unwittingly or unavoidably exposed to the contagion of fever in overcrowded and ill-ventilated apartments, sanitary visitation can only be an imperfect check upon the spread of this disease. The strong convictions I entertain on this subject, and the very decided support afforded to those convictions by the facts of the present epidemic, have induced me to recommend a more stringent application than heretofore of the new powers conferred by the Glasgow Police Act, in two of the most notorious fever localities; and I shall be guided by the effect of these recommendations in making further efforts in the same direction. It is of importance that in the application of these stringent clauses there should be nothing ill-considered, nothing arbitrary or indefensible. I am, therefore, well content that these two cases should be fully and clearly before the public as a basis for future action; and I hope that, by securing in advance the influence of free discussion and the support of public opinion to the measures proposed, they will be rendered both more safe and more efficient for the purpose in view—the gradual reformation, and in some cases reconstruction, of the houses of the poorer classes, in accordance with those conditions which can alone deprive epidemic disease of its most dangerous peculiarities."

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* See his 'Essay on the Physical Causes of the High Rate of Mortality in Liverpool.' Liverpool: Walmsley, 1843.

† P. 49, loc. cit.

‡ P. 63, loc. cit.

§ By Dr. Currie. See conclusion of Dr. Duncan's Essay.

‖ See his 'Reports for April and July, 1863.' Glasgow: Robert Anderson.

And what are the "two cases" to which reference is here made?

We will give them, as far as these pages can do so, the publicity which Dr. Gairdner desires that they should enjoy, stating, however, at once, that through the unwearied efforts of that gentleman, these two plague spots, if they are not completely eradicated from the city that witnesses his labours, are at least no longer injurious to its inhabitants.

One is "Binnie's Court, 285, Argyle Street," in which we are told that thirty cases of fever had been visited between November, 1862, and April, 1863. This, we imagine, will wear, in the eyes of our readers, very much of the aspect of a chronic pestilence! And no wonder that it should exist there, for the building, or whatever it may be called, "is six stories in height, including the sunk floor, and in each story there are twelve apartments, principally let in single rooms to the working classes." These rooms were in such an overcrowded state that it was "dangerous to public health, and permanently injurious to the health and morals of the inmates." Some of the single rooms used as dwelling-houses contained only 600 cubic feet of space, and were occupied by four or five persons, "whilst the Act requires an *absolute minimum* of 300 cubic feet for each person over eight years of age, and 150 cubic feet for each person under that age."

But the second case, "No. 83, Drygate Street," was still more dangerous. It is known as "The Rookery," and "may be described generally as an almost perfect example of a deliberate plan for bringing together the largest number of persons in the smallest amount of space." The state of things to be found here beggars all description; an apartment of 497 cubic feet contains six adult inmates, "each of whom can scarcely have more than *one-fourth* of the minimum space allowed by the Police Act." . . . and "*the average size of the single rooms, intended for the habitation of a whole family, is but little greater* *than that formally condemned by the Royal Commission as insufficient for a single soldier in barracks!* The amount of over-crowding in most instances may be easily imagined by any one who will take the trouble of measuring a space eight feet in each direction, and assigning it in fancy as a habitation for six adults. It is hardly necessary for me to say that I find in the facts above mentioned ample explanation of the prevalence of typhus fever in the Rookery." This is the first part of Dr. Gairdner's evidence, and no one will, we think, be disposed to dissent from his conclusions. There will be no need for tender-hearted readers hereafter to shudder over the accounts of the tragedy in the Black-hole at Calcutta; the report of Dr. Gairdner, and others, to which reference has still to be made, will furnish records quite as horrible, and even more repulsive in details.

But it is not necessary to confine our inquiries to our own country, for accumulated evidence of the truths advanced above is also to be found in the reports of the Sanitary Commission of Paris. This body of gentlemen, known as the "Commission des Logements Insalubres," was constituted in 1850, and forms a permanent commission, with full power to reform the character of the dwellings of the working classes in Paris. A passing notice of the constitution of this board may be useful to the English people, for it is not made up of amateur legislators only, whose interests (as we have already seen) are not always in unison with the public good, and upon whom an inconvenient pressure may often be brought to bear by selfish and awkward constituents, but it consists—1st, of public officers appointed by the State, such as the Inspector-General of "Ponts et Chaussées," the Water and Sewer Engineer, the Superintendent (chef de division) of Public Works, and four other gentlemen holding public appointments; 2nd, of members appointed by the Municipal Council, comprising the leading medical men attached to the various hospitals, of chemists, engineers, architects, one of the judges of the Civil Tribunal of the Seine, and private individuals; and 3rd, of supplementary members, also appointed by the municipality, as circumstances may direct.

The results of having a committee thus constituted are unanimity of action and the issue of just and feasible recommendations. Those who have watched the efforts which have been made in England to enforce sanitary reforms by bringing the offenders before the lay magistrates must have noticed that differences constantly arise between them and the guardians of the public health, and that private feelings and prejudices are often an increment in the judicial decrees; but in the French Commission no such difficulty is to be apprehended, inasmuch as different members of the commission are competent to decide in all matters of law and detail with the same precision as if they constituted a final court of appeal.

A further advantage in the operation of the French Commission over some of our local boards, is the *moral* influence which its decisions carry with them. In England an offender may often feel that his security lies in the chance of the magistrate taking a lenient view of his case, and differing from the sanitary officer, and so he may be induced to turn a deaf ear to the voice of justice and morality until the law compels obedience; whilst in Paris it is so well known that the criminal tribunals are sure to endorse and give effect to the well-considered recommendations and decisions of the "Commission des Logements Insalubres," that offenders are only too glad to repair the breach of the law (as we shall presently find they do in the large majority of cases) by what our neighbours call a settlement "à l'amiable," an expression so *expressive* that there is no need for its translation.

In the Report issued by the Commission for 1852 to 1856 inclusive,* we find the following pointed out as the prevalent causes of disease—unhealthy interiors (of dwellings), resulting from want of cleanliness, insufficient light, imperfect ventilation, want of space, occupation of cellars, imperfect water supply, inefficient drainage, humidity, and overcrowding! precisely the same catalogue of evils that have so long desolated the homes of the poorer classes of Britain; and in a later Report† of its labours, the Commission refers particularly to the character of the cellars which are deemed unfit for human habitations. Some of these are described as mere caves, into which a little light and air is admitted through external openings, and it is to these especially that the attention of the Commission has been directed. They have, of course, prohibited their use as day and night dwellings.

In perusing these reports we may be permitted to remark en passant, that it is impossible not to perceive the fitness of the present form of government in France for certain of the people's wants, and the need that exists for caution in pronouncing upon the suitability of this or that mode of legislation. Imperial rule in Britain would be out of place, and centralization is the abhorrence of Englishmen, but if our readers were to glance over these reports, they would find that the acts of the French legislature in ameliorating the condition of the working classes are probably the very best that could be devised, looking at their position in the moral and intellectual scale, and that there exists a thorough understanding between the people and its rulers.

Whilst with us private individuals, companies, and municipal councils are occupied with the "Utilization of Sewage" question, in France the initiative is taken by the State; and in furtherance of another important matter, usually promoted in England by private individuals, namely, the erection of model lodging-houses, we find the coffers of the Imperial Treasury freely opened; for we are told in the report referred to, that his Excellency the Minister of the Interior having acquainted himself with the nature of the project for providing lodging-houses for the working classes at Lille, had granted 100,000 francs to facilitate the construction of these dwellings. It is a pity that we English cannot find it in our hearts to cast away a little of our self-complacency, and that we do not study the ways of our neighbours with a view rather to profit by their good example than to criticize their imperfections.

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* 'Commission des Logements Insalubres.—Rapport Général sur les Travaux de la Commission pendant les années 1852, 1853, 1854, 1855, et 1856.' Paris: Charles de Mourgues Frères, successeurs de Vinchon, Imprimeurs de la Préfecture de la Seine. Rue Jean-Jacques Rousseau, 8. 1857.

† 'Rapport, 1857, 1858, 1859.' Same publishers.

The report of the commission gives a list of the cases in which it has interfered, and we find that in 1857 there were 492, of which 369 were adjusted amicably, and the remaining ones referred to courts of justice; in 1858, 512 cases, whereof 355 pleasantly terminated; and in 1859, 641 cases, of which 373 were amicably settled; thus it appears that the Commission finds its reformatory labours extending and becoming more and more difficult in execution.

Let us now turn again to our home records of a more recent date, and we shall find that although our Boards and Committees of Health have been unremitting in their exertions to suppress the unhealthy and demoralizing conditions of the poorer classes, yet their extended inquiries have revealed a state of things almost too repulsive to be transferred from the cold and formal reports of medical officers intended only for the guidance of local boards, to the pages of a Journal destined for the general reader.

But in the fulfilment of our task, it is absolutely necessary that we should extract a few of the more flagrant cases of neglect and ignorance, often bordering upon crime, which, as we have already stated, are sapping the very foundations of our social system and converting our crowded cities into hotbeds for the reception of epidemic diseases.

In his report for August, 1864, Dr. Gairdner, the medical officer of Glasgow, tells us that he sometimes feels completely helpless when he "sees diseases, as measles, hooping-cough, and scarlet fever, running riot in the houses of the poor;" he feels that, in most instances, nothing can be done beyond a general instruction to open the windows, and attend, if possible, to cleanliness. He further states that he has found provisions publicly sold from infected apartments, instancing a case where "a woman with the eruption of smallpox actually on her hands, was found selling sweetmeats to the children of a school in her neighbourhood!" If such a story had been told in some romance of 'The Plague of London,' or if it had found its way into 'The Mysteries of Paris,' it would not have been out of place; but it is enough to chill the blood in one's veins to read it as an actual fact in the report of a medical officer of health in 1864.

And what is the remedy for such a state of moral darkness? Dr. Gairdner tells us that the law is incapable of dissipating it, and that "the spread of epidemic disease among children can hardly be met otherwise than by the gradual diffusion of enlightenment, and by the improved habits which, it is to be hoped, may arise from the remodeling of the dwellings of the poor over a long course of years."

Even the attempt to prevent the overcrowding of those dens which are at present used as dwellings for the poor is not always successful, and although it is a matter for congratulation that the two infamous localities referred to in a former part of this paper, "the Drygate Rookery" and "Binnie's Court," are to a great extent freed from epidemic fever, in consequence of sanitary improvements, yet Dr. Gairdner tells us, that "in another street in the same neighbourhood (in which a great deal of fever has been reported), fifty-two houses have been ticketed, all of these, except four, being houses of single apartments; the proper complement of these fifty-two houses, according to the terms of the Police Act,* is 154 adults, and yet on the June visit of the police, there were found 186 adults and 64 children, almost all single families without lodgers." Dr. Gairdner does not consider the landlords responsible for this overcrowding, for the houses are usually sub-let; but he urges the owners only to let the houses subject to the regulations of the Police Act as to overcrowding. Neither does he recommend summary evictions, which cause great inconvenience and distress, and simply transfer the evil complained of (overcrowding) to some other quarter, perhaps to some previously untainted locality; but like the Paris Commission, he recommends that all cases should, if possible, be amicably adjusted and sanitary reforms introduced into the habitations where the exciting causes of disease have been seated; in fact, that a good understanding should be cultivated between the authorities and those who are unfortunate and ignorant, rather than wilful offenders against the laws of nature and society.

The Paris Commission, whose reports testify through their increasing bulk to its great activity, has, during the last four years, performed marvels in the way of sanitary reform.† They have had a difficulty to contend with, happily no longer experienced here; namely, an imperfect water supply for the interiors of dwellings. "In Paris," the report says, "fountains are multiplied, and many of them serve at the same time for the embellishment of the city and to satisfy its domestic wants, whilst in London, there are no public fountains, no monuments, nothing to adorn the public thoroughfares, but all is reserved for the interiors of the houses: thus the differences in the manners of the two peoples are revealed;" and then it goes on to speak in terms of high commendation of the water-taps, and water-closets, and shower-baths found in England in the houses of working men paying 125 to 150 francs rent; luxuries supplied to the fortunate tenants at an annual charge of about eight francs, or 5 per cent. on the rent: 'A Rugby, petite ville de 8,000 habitants, sur les 1,100 maisons 700 à 750 ont exécuté leurs prises d'eau et ont au moins deux robinets, l'un dans la cuisine, l'autre au water-closet." We fear that our French readers will not think so highly of our sanitary arrangements after the revelations which we are compelled to make, but certainly the picture that has been drawn of us by the Sanitary Commission of Paris, may well serve to obliterate from the minds of indignant Englishmen those sketches of English society with which some French penny-a-liner lately entertained his countrymen. *Thinking* Frenchmen seek out the useful traits in the social life of England, and turn them to good account, and it would be well if thinking Englishmen would profit by the good taste of their neighbours, and employ their resources in the erection of public structures that shall at once adorn our cities and supply our social requirements.

The Commission, as we have said, finds the need of a better water supply to the tenants of houses, for they observe, that there can be no health without cleanliness, and no cleanliness without abundant and wholesome water; and when therefore this sanitary element is absent, the Commission does not hesitate to enforce its introduction. Thus, they describe a house in the "Rue de la Montagne Sainte Géneviève, containing 200 inhabitants in 80 different apartments, besides a school, and yet this whole structure is without water supply, and the inmates have to seek that commodity out of doors." Consequently the commission "recommended that the proprietor be instructed to place at the disposal of the tenants wholesome water sufficient to guarantee the cleanliness of the various apartments and offices." Of course, the "recommendation" is law, and it is pleasing to observe, that whilst the Commission are inflexible in their determination to reform the habitations of the poor, they have recourse to extreme measures only as a last alternative. "Thus," they say, "when we decide upon rigorous measures, such as the interdiction of a dwelling, it is only after a searching inquiry, repeated visits, and earnest deliberation," and in all cases they seek first to act as mediators between landlords and tenants, before exercising their legislative functions.

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* See Dr. Gairdner's 'Report, August 1, 1864, p. 12, note. 'Glasgow Police Act.'

† 'Rapport Général, &c., 1860–61.' C. de Mourgues Frères. Paris, 1863.

Wishing our neighbours every success in their sanitary reform, and perfectly satisfied that the spirit in which they are conducting their operations will *ensure* success, we once more, and for the last time, turn to the sad pictures of wretchedness and to the threatening dangers which present themselves in our own large towns. In his last Report for 1864,* Dr. Trench, the medical officer for Liverpool, referring to the causes of disease, attributes it to—1st, Contagion; 2nd, Indigence; 3rd, *Overcrowding;* 4th, Emigration; 5th, *Sub-letting rooms;* 6th, *Filth;* † 7th, Drunkenness. Of overcrowding he gives some examples which are really almost incredible; and whilst he tells us that it would be impossible to find 40 men sleeping in a cellar, as described by Dr. Duncan, still we fear our readers will think with us, when they have heard how matters stand at present, that there is much room for sanitary reform.

Remembering that the minimum cubic space required for each adult (by the Glasgow Police Act, and Liverpool Board of Health), is 300 feet, and that the Government Commissioners recommended 700 and 800 feet per man for soldiers in barracks, we will now conduct our readers to two or three of the *homes* visited by Dr. Trench or the Inspectors.

The first is the lodging-house of Mary Bartley, No. 9, Trueman Street, Liverpool. It contains eight rooms, one of which was found empty, and another was used as a kitchen by the tenant, the remaining six rooms constituted dwelling-houses for families, there being in all twenty inmates in the six rooms, and in one of the rooms, 998 cubic feet in its dimensions, *two young married couples were found to exist, with only one large straw mattress for a bed!* Two couples of young married persons thus herded together by day and by night, in a room measuring less than 10 feet in every direction, breathing the same air over and over again! What a favourable condition of existence for the cultivation of the higher, or even the lower moral faculties! Again we say, it is enough to make one shudder to read of such scenes, chronically existing in the very midst of our boasted civilization.

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* 'Report of the Health of Liverpool during the year 1864.' Liverpool: Greenwood.

† We italicize the words.

But there are still worse cases. In No. 27, Chisenhale Street, Michael Lonergan occupied a house, one room of which, 802 cubic feet in measurement, served as the abode of three persons. Mary Roach, 19, Brick Street, rented three rooms, together about 2,700 to 3,000 feet, sheltering seventeen persons! Sarah Goughran, No. 21, in the same street, had also three rooms, containing the same number of persons, and in these rooms, *there was literally no furniture whatever; men, women, and children lying together promiscuously on straw, or on the bare boards!* *

We recommend these cases to the consideration of all pious persons, whose philanthropy finds its issues in public speeches in favour of African missions, or in the propagation of the gospel among the Jews, or in foreign parts!

And now as regards the absence of cleanliness, the nature of the subject compels us to be still more brief. "Any history," says Dr. Trench, under the unsavoury heading of 'Filth,' † "any history of the causes favouring the extension or diffusion of typhus, would be incomplete which did not include the filth, foul smells, and vitiated air *within* rooms; or the noxious exhalations from open middens and heaps of decomposing vegetable and animal refuse in the immediate neighbourhood of houses. It would indeed be difficult to overrate the force of such auxiliary and predisponent influences, which are only second, if at all inferior, in magnitude and importance to those of either destitution or overcrowding." We will spare our readers, many of whom are, we feel sure, as much pained to read, as we have been to write these shocking details, the unpleasant task of wading through the quagmire that follows, but to demonstrate once for all that filthy, overcrowded, and otherwise unhealthy homes *are* the true causes of the spread of pestilence, we select from Dr. Trench's 'Analysis of Deaths from Typhus during one week,' the following cases:—

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* Since this article was written, official reports have described even more unhealthy and immoral scenes of overcrowding in country districts than any here noticed as existing in our large towns; and if any further evidence were needed to establish the causes of typhus and other epidemics, it is to be found in the Report of the Government Inspector, from which we make the following extract:—

"To sum up:—Destitution, dirt, and intemperance, with overcrowding and bad ventilation of streets and houses, are the conditions that keep up the disease steadily from year to year. The reasons why typhus has become epidemic are not so clear. The only positive conditions that have been ascertained appear to be these—slight but steady increase in overcrowding, some increase of immigration and of distress at the end of 1861, some increase of vagrancy, and with these some influence in each autumnal season. But these causes are not sufficient to account for the epidemic. Typhus, like other contagious diseases, fluctuates in its amount at different periods; at one time occurring in scattered cases only, at another time extending widely over the community. What determines it to assume the epidemic form can sometimes be made out—an exceptional intensity of the conditions that foster it in ordinary times. But sometimes its prevalence as an epidemic cannot be thus explained. Like other diseases of its class, *with predisposing conditions apparently constant*, it has times of subsidence and times of prevalence that medical science cannot yet explain.

"The negative conclusion at which this report arrives concerning the causes of the present epidemic may appear at first sight unsatisfactory. But it is not without its value if it shows that efforts for preventing epidemics of typhus must be applied not chiefly at the times of the epidemic itself, *but to the improvement of certain habitual conditions that can be recognized as fostering the disease in ordinary times.* Some of these conditions are within the range of public sanitary measures, others are connected with social circumstances over which no direct public control can be exercised." (The italics are ours.)

† 'Report of 1864,' p. 35.

"*First death.*—An office clerk. He had a wife and four children, and earned 20*s.* a week. 'The wife supposed to take drink.' *The house dirty and poorly furnished.*"

"*Second death.*—A carter. He had a wife and one child, and earned on an average 20*s.* a week. His wife 'addicted to drink heavily.' Of the house it is added, '*Poverty and filth in the extreme.*'"

"*Third death.*—A labourer's child. The labourer's family consisted of wife and five children, and he earns 3*s.* a day, occasionally. 'A steady man, with a drunken wife.' '*The house having every appearance of misery and filth of the lowest order.*'"

"*Fourth death.*—A labourer's child. 'The parents have left the house. They were comfortably off as regards money.' 'Continual drunkenness *and filthy in habits.*'"

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"*Tenth death.*—A market porter's child. The family consisted of man, wife, and four children. The average earnings 12*s.* to 15*s.* per week. No information respecting morals, but thinks, by appearance, a deal of dissipation. *Dirt and destitution in the house.*"

In many of the other cases we find the words "intemperance, dirt," &c.; and it will be observed that in every case quoted, it is not the drunken mother, but the unfortunate father or innocent child, whose unhealthy home makes him the victim of disease and death. What becomes of the wretched mother, when she is left with her tribe of sickly children, and is deprived of the means of indulging in the vice that has converted her into the slayer of her husband or child, we leave to the imagination of our readers!

To some of the last-named it may appear that we have needlessly dragged to light scenes of wretchedness and demoralization which might have been passed over in silence, and that we should rather have suggested the remedy than have entered into the details of the existing disease. But, alas! if we turn to the account of the means that have been adopted for remedying the evil we find the same horrible phases, and, as it may naturally be supposed, we perceive that the present state of things can only be completely reformed by tearing out the tree at its very root—so that whether we take up the records of existing pestilence, or those of the reformatory measures that have been adopted for its eradication, the same repulsive features constantly present themselves. There exists in the very heart of our civilization, a loathsome sore which no dainty fingers can heal, and no sentimental suggestions can ameliorate; but which *men* and *women* must help to root out from the social system. The cures for overcrowding are to be found, in model lodging-houses, in small well-built and well-fitted cottages, such as are springing up in all the outskirts of our great towns; in the encouragement of "Home Missions," and Educational Establishments for the poorest children; and generally in the *firm* but *conciliating* interference of local authorities in sanitary arrangements. All these matters require that false delicacy should be put aside, that much self-denial should be exercised both by giver and receiver, and that the great mass of the people should be awakened to the dangers in the midst of which they have so long reposed in security. Does it not seem a dreadful thing to say, that if a conflagration were to sweep over a very large area of Liverpool, London, Glasgow, or indeed over the low parts of any of our overcrowded cities, it could only be regarded as a blessing to the wretched creatures who would be temporarily rendered homeless? And yet who will deny it, after reading Lord Shaftesbury's statement,* that when "Wild Court, Drury Lane, London, was rendered habitable by the 'Labourers' Friend Society' (who pulled down the houses and rebuilt them as models), the vermin lay beneath swarming in living masses in layers, from two to three inches thick, and that the well-known insects ejected from the houses amounted at least to a ton's weight."

We might refer fully to the labours of the late Prince Consort, Lord Kinnaird, Earl Shaftesbury, Miss Burdett Coutts, Mr. Peabody, the managers of the "Labourers' Friend Society," the Rev. Cecil Wray (of Liverpool), Mr. Peacock, and others, who, from philanthropic motives, have promoted the erection of healthy dwellings; but these examples are, from their very rarity, so well known, that it is needless to dwell upon them. There is another feature in the model lodging-house movement which deserves special attention. When conducted with a view to profit, as it has been both by private individuals and Joint Stock Companies Limited, the adventure is remunerative, and this is the guarantee for its extension. We have looked over the reports of existing Models, and watched the growth of small cottages situated even at a distance from the centres of labour, and they leave no doubt concerning their success as pecuniary investments. There are many persons, not always of the wealthier classes, who would gladly give their thought and leisure to supplement the capital of those to whom 10*l.* or 50*l.* is no object, and would aid in the formation of Joint Stock Model Lodging-house Companies; and there is no reason why such establishments should not be at least as plentiful as hotels—if not as *gin shops!*

Here, then, is one of the great resources of modern wealth and civilization which can be advantageously applied to remove the prevalent causes of contagious disease; and not alone will philanthropists be easily found to undertake the formation of the new abodes for the unfortunates whose "homes" we have been describing, but the officers of health will be grateful to these who provide shelter for the poor diseased creatures whom the police regulations will inevitably turn into the streets, or drive into pure and still untainted localities. We trust, then, that the effect of this article will be, not only to create a little sensation and sympathy for those who at present live in our cities herded together as cattle, or like slaves in a ship's hold, but that it may here and there move the hearts of good men and women to assist, with heart and hand, in the foundation of self-supporting model lodgings. Another good plan of reforming the unhealthy habits of the poor which has been discussed, but not, we think, practically or extensively followed out, is the distribution, in the lowest neighbourhoods (through the medium of town missionaries, *and of the more intelligent of the class intended to be benefited*), of very brief, pithy instructions for the sanitary regulation of homes: stating, for example, the best means of ventilating crowded rooms, and the consequences of the neglect of such precautions, inculcating the necessity for cleanliness, &c. Here is a work for our Mutual Improvement Societies and Literary Institutions, which will be far more useful to society at large, and to the members themselves, than debates upon historical subjects long since exhausted.

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* See 'The Report of the Lodging House Committee,' prepared by Dr. Trench. Liverpool: McCorquodale (1864).

These are but two or three out of a great many ways in which the general public, or earnest individuals, can aid in the reform of the dwellings of the poorer classes; but there are still others. In Liverpool, a lady, whose name we forbear to mention, as it may not please her to have it published farther than her good deed has already made it known in her own town, communicated to the Health Committee of the Town Council her wish that they should pull down a house of which she was the proprietor, and which she had been advised was unfit to be used as a human habitation. We hardly expect that many others will be found willing to follow the example of this excellent lady, but there may be some who would prefer this course to leaving such plague spots as legacies to their posterity.

And again, the Railway Companies, who do not stand very high in popular estimation at the present moment, may win golden opinions by facilitating the transit of labouring men to and from their workshops or sheds, and thus helping them to remove their dwellings to healthier localities;* and Companies so disposed would not only be doing a good work, but would undoubtedly be acting in the interest of their constituencies.

As the title of this paper indicates, its original object was to point out the predisposing causes of what is vulgarly known as "plague" or "pestilence;" but the terrible scenes that have presented themselves during its composition have induced us to deviate somewhat from the original plan, to draw the attention of our readers to those remedial measures which are being employed to remove the impending dangers. None will be disposed to gainsay that we are not surrounded by conditions in the highest degree favourable for the reception or extension of any new epidemic, or any exaggerated form of an existing one, that may visit us; and we therefore conclude these remarks with the expression of an earnest hope that amongst our scientific readers, who must, indeed, be fully alive to the grave nature of the evils to which attention has been directed, many will be found to give the subject their serious consideration, and who will bring energy and experience to bear in the work of their eradication.

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* As is already done in the Metropolis.

AMERICAN CONTRIBUTIONS TO SPECTRUM-ANALYSIS.

BY HENRY DRAPER, M.D.,
Professor of Natural Science in the University of New York.

ALTHOUGH the fact that a ray of white light consists of several differently coloured rays has been known since the time of Newton, it is only recently that any use has been made of it, in attempting to determine with precision the chemical composition of substances, from the characteristics they impart to flames. A long stage of preparation for perfecting such discoveries is necessary, and a multitude of preliminary observations have to be grouped and digested. Eventually, some striking application of the knowledge thus gained arises, and the subject becomes popular among scientific men, who had failed to see any interest in the previously isolated experiments. It was not, for instance, until Bunsen and Kirchoff ascertained the presence of cæsium and rubidium in certain mineral waters, by the aid of the spectroscope, that that instrument attracted the attention it deserved. Even the suggestion that by its aid the physical constitution of the sun and stars might be ascertained, had not sufficed to bring it into notice.

The application of Spectrum-Analysis to Chemistry turns on the fact, that several, if not all, the elements impress a special change on a flame in which they may be volatilizing. In many cases the change is obvious to the eye, while in others it is necessary to pass the light through a prism, in order to observe with precision what has taken place. We have not, as yet, any knowledge of the reason that some bodies in volatilizing give rise to undulations of a particular length, and others to an entirely different group, we merely know that such an element as sodium, for example, causes vibratory movements, whose length is a definite fraction of an inch, and which pulsate a given number of times in a second, and that *no other element can do the same.* Whether the hypothesis of Professor Hinrichs of the Iowa University, that the discovery of the laws governing the distribution of the spectral lines will lead to a knowledge of the relative dimensions of atoms will turn out to be true or not, remains to be seen. If it be true, Optics would do for the determination of the form and size of atoms, what Chemistry has done for the determination of their relative weights.

The earliest American experiments in relation to the Constitution of Flames, the Solar Spectrum, &c., were published by Professor John W. Draper, in the 'Philosophical Magazine,' 'Silliman's Journal,' and 'The Journal of the Franklin Institute,' commencing in

1834. As these results were attained at a period when the number of facts known was limited, and when the interest in the phenomena of light now excited did not exist, an abstract of them may be presented with advantage.

Professor Draper's Researches.—The general plan of these investigations, which occupied many years, was—1st, to determine the conditions of incandescence of solid bodies; 2nd, the nature of flames; and 3rd, their variations at different temperatures. I shall therefore speak of them in that order, premising some remarks on the forms of spectroscopes that were used.

I. *Spectroscopes.*—The spectroscope first employed was similar to that used by Fraunhofer, consisting of a distant slit, a prism either of flint-glass, or bisulphide of carbon, and a telescope when visual observations had to be made, but suitably modified for photographic investigations. As is generally understood, this form of apparatus will give very excellent results, but the space occupied by it renders it less manageable than the more recent forms. By its aid, modified, as has been said for photographic purposes, the extra-spectral fixed lines above H, *viz.* M, N, O, P, were discovered by Dr. Draper, as impressed on a daguerreotype plate, and an engraving of them published in the 'Philosophical Magazine,' for May, 1843. He estimated that there were were about 600 of these lines so impressed between H and P. In like manner three lines, α, β, γ, of less refrangibility than A, were also detected. These latter lines were attributed to absorption by the earth's atmosphere, the others to the atmosphere of the sun.

But Dr. Draper also made use of another form of spectroscope, which does not seem to be even yet thoroughly appreciated. He replaced the prism with a grating or finely-ruled reflecting surface, the advantage of this being that the absorption of dioptric media was avoided, and the fixed lines, as it may be said, occupied their proper positions in the order of their wave-lengths. The prism separates the lines unduly towards the violet end, and crowds them together towards the red. On the contrary, in the interference spectrum from a grating, the yellow is in the centre, and the light declines away towards the violet end above, and towards the red below.

With this form of spectroscope the fixed lines were photographed, as in the other instance, and maps of their position published. By its use also, Dr. Draper was enabled to settle the question, which could not be determined so decisively with the prism, namely, the distribution of heat. It was shown that the centre of the yellow space is the hottest, and not a region less refrangible than the red, as is the case in Herschel's prismatic experiments, and that from that point the heat intensity declines towards the violet above, and the red below.

In these delicate heat experiments, advantage was taken of investigations that had been published by the same author in the 'Philosophical Magazine,' June, 1840, under the title of 'Electro-motive Power of Heat;' and in which some exceedingly delicate forms of thermo-electric combinations had been described.

II. *Of the Incandescence of Solids.*—The first formal memoir of the series now to be considered, was published by Dr. Draper in the 'Philosophical Magazine,' May, 1847, under the title of 'The Production of Light by Heat.' The chief points experimentally determined in it are the following: 1st, that all substances become red hot at the same thermometric degree, which is 977° Fahr.; 2nd, that the light of an incandescent solid examined by the spectroscope is continuous, or without lines or breaks; 3rd, that at the same temperature there is always emitted the same ray; 4th, that as the temperature rises, rays of increasing refrangibility are added, and when the substance is intensely white hot all the rays of the solar spectrum are present. By direct photometric measures, founded upon the principle known as that of the extinction of shadows, he proved that the brilliancy of the emitted light increases more rapidly than the temperature. He also gave the true explanation of that apparent increase downwards, in the less refrangible rays, which the spectroscope exhibits at high temperatures, as depending on the physiological peculiarities of the eye.

It may, in passing, be remarked that a strip of platinum ignited by a regulated voltaic current, was in these experiments recommended as a UNIT LAMP, or standard source of light and heat, in the mode that has since been followed by Professor Tyndall.

Of so much importance was this memoir considered by Melloni, that he read an abstract of it, and critique upon it, before the Royal Academy of Sciences at Naples.

It is greatly to be regretted that M. Kirchhoff, in the memoir he published in 'Poggendorf's Annalen,' and of which a translation was printed in the 'Philosophical Magazine,' July, 1860, did not profit by the example Melloni had set. On page thirteen of the last-quoted work the facts that a platinum wire, as its temperature is raised, emits rays of increasing refrangibility, that all bodies become red hot at the same temperature, and emit special rays at special temperatures, that the spectrum of an ignited platinum wire is continuous, are presented as the results of his own mathematical investigation. From the obscure foot-note upon that page, no reader would ever infer that all these points had been proved by experiments by Dr. Draper many years previously.

III. *Of Flames.*—In continuation of the preceding investigation, Dr. Draper published, in the 'Philosophical Magazine,' February, 1848, a Memoir on "The Production of Light by Chemical Action." In this, resorting, as has been subsequently continually done, to a solar spectrum as the standard, and to the fixed line D, tables were published of the spectra of alcohol, carbonic oxide, cyanogen burning in air, cyanogen burning in oxygen, oil in air, and also in oxygen, hydrogen in oxygen, nitrate of strontia, &c., as seen in the spectroscope. The convenience of reducing these flames to the yellow ray D, has since been universally recognized. In like manner five such tabular results of platinum ignited to different temperatures, referred to the solar spectrum as a standard, had been previously published. In the case of flames, the line D in these memoirs is described as Brewster's yellow ray, in commemoration of Sir David Brewster's discovery of the monochromatic character of a sodium light. In both these spectroscopic and also photographic experiments, the principle of identifying effects by wave lengths was resorted to, a suggestion naturally occurring from the use of the interference spectrum.

IV. *On the Variations of the Light of Flames with the Temperature.* —One of the most important facts demonstrated in these memoirs, indeed, it almost rises to the position of a general law, is this—"*that the more violent chemical action the more refrangible the emitted light.*" In the combustion of an elementary solid, such as carbon, if air be more and more vigorously supplied, rays of continually-increasing refrangibility emerge, and if, instead of air, oxygen be used, the resulting spectrum rivals that of the sun in brightness and extent. On this principle, that increasing vigour of chemical action implies increasing frequency in vibration, Dr. Draper gives an explanation of the colours emitted by flames. Thus carbonic oxide burns with a blue light, because it needs but little oxygen to complete its combustion, but the light of burning cyanogen increases in refrangibility when its combustion is made in oxygen gas. Among the most striking of these results, as showing the complete control that the circumstances of a combustion have over the character of a flame, is the extraordinary spectroscopic appearance of the blue blowpipe cone, when contrasted with the flame from which it originates, a singular instance which has been much overlooked. In descriptions of the changes in the spectrum caused by variations in the rate of combustion, the appearances produced by substances volatilizing in a flame, must not be confounded with those produced by a body that is oxidizing. There is no reason at present to believe that the spectral lines in the former case can be made to alter their position by increase of temperature, although new ones may be rendered visible.

In these memoirs, and also in others 'On Phosphorescence,' and 'On the Chemical Action of Light,' subsequently published, there is a multitude of facts and observations, full of interest, but too numerous to quote in this abstract. Among such, perhaps, I might mention the Chlorine and Hydrogen Photometer, subsequently used so extensively by MM. Bunsen and Roscoe, and the attempt to show that the Fraunhoferian lines are arranged in a certain symmetrical order, herein to some extent anticipating the remarks of Professor Hinrichs, before referred to. It should also be added that many other experiments in Photo-Chemistry were published by Dr. Draper, in a quarto volume of 324 pages, illustrated by engravings, under the title of 'A Treatise on the Forces that produce the Organization of Plants.'

Mr. L. M. Rutherfurd's experiments.—'Silliman's Journal,' Nos. ciii., 1863; cv., 1863; cvi., 1863. In December, 1862, Mr. Rutherfurd determined to continue Fraunhofer's experiments on stellar spectra by means of a refracting telescope of $11\frac{1}{4}$ inches aperture, mounted equatorially, and driven by a clock. He used at first an ordinary spectroscope, with the slit inside the focus of the large achromatic, but finding the loss of light upon the jaws of the slit to be very great, eventually employed a cylindrical lens, as Fraunhofer had done. This also frees the spectrum from longitudinal lines. He observed that a spectroscope thus mounted is useful for determining the achromaticity of the telescope. If the different rays have foci at different distances from the objective, the slit must be moved in order that each ray may pass as a point. The place of the photographic focus may be thus ascertained with precision.

Mr. Rutherfurd examined the spectra of the Sun, Moon, Jupiter, Mars, Capella, β Geminorum, α Orionis, Aldebaran, γ Leonis, Arcturus, β Pegasi, Sirius, Castor, α Lyræ, α Aquilæ, Procyon, Regulus, β Ursæ Majoris, ζ Ursæ Majoris, ε Ursæ Majoris, δ Ursæ Majoris, and printed a plate of them in 'Silliman's Journal,' vol. xxxv., May, 1863. α Virginis, β Orionis, ε Orionis, δ Orionis, ζ Orionis, α Ursæ Majoris, gave no lines. He found absorption bands in the spectrum of Jupiter between C and D, and suggests the explanation that these, together with the remarkable bands of α Orionis, Aldebaran, and β Pegasi, may be due to the action of the atmospheres of those bodies. He classifies stellar spectra into three groups. 1st. Those resembling the Sun, as Capella, β Geminorum, α Orionis, Aldebaran, γ Leonis, Arcturus, β Pegasi; all reddish or golden stars. 2nd. Those of which Sirius is the type, wholly unlike the sun, and white. 3rd. Those like α Virginis, white, but showing no lines; they are perhaps incandescent, without flame, or contain no mineral substances. A great difference in the composition of stars is rendered evident.

Another communication in the same volume commences by giving a number of measurements of the companion of Sirius, and demonstrates that it has changed 3° 37′ in angular position, and 0·55″ in distance in a year, which would give a period of about 100 years if the plane of motion is perpendicular to the line of sight. He mentions a change made in his stellar spectroscope, by which a sodium flame is kept constantly in the field. By the check thus established, he proves that each line of the spectrum of Arcturus has its counterpart in that of the sun. His large spectroscope is also alluded to. The telescopes are 20 inches of focal length, and $1\frac{6}{10}$ inches aperture. It has six prisms of brass, with plane glass sides. He finds that the bisulphide of carbon is very changeable in density, and that the brass frames disturb the plane glasses when there are great variations of temperature. On examining the line D, it is seen to be composed of nine lines, a result subsequently corroborated by the use of eleven prisms: the line B is resolved into fourteen. He also describes other peculiarities, particularly in the neighbourhood of A, and in the potash spectrum.

In a letter in No. CVI., Mr. Rutherfurd criticises the stellar spectroscopes of Donati, Airy, and Secchi, giving the preference to the last, because it effects the separation of the lines by the dispersion of its prisms, rather than by the power of the observing telescope, and because it possesses the means of constant reference to a standard flame. He remarks that in the line D, four of the nine component lines are solar, the rest telluric, because these latter, though difficult with eleven prisms at noonday, are seen with ease near sunset with two. This conclusion is similar to that of Dr. Draper, concerning the invisible lines α, β, γ, discovered by him below the red end of the spectrum.

Mr. Rutherfurd has also taken photographs of the solar spectrum on the same scale as the map of Kirchhoff, but no detailed account has as yet been published. His other labours in celestial photography, and more particularly his lunar pictures, are so well known that no description of them is necessary.

Professor Rood's Experiments.—In 'Silliman's Journal,' No. C., for 1862, there are some facts concerning the spectrum afforded by nitrate of didymium. Gladstone had originally found that light, transmitted through dilute solutions of this salt, showed two dark lines in its spectrum. Professor Rood, on causing the light to go through a thickness of 12 inches of a strong solution, found that the spectrum was crossed by twelve distinct bands. The sodium line is cut off by one of these bands, and hence a sodium flame is invisible through this solution, though white objects are but slightly tinted.

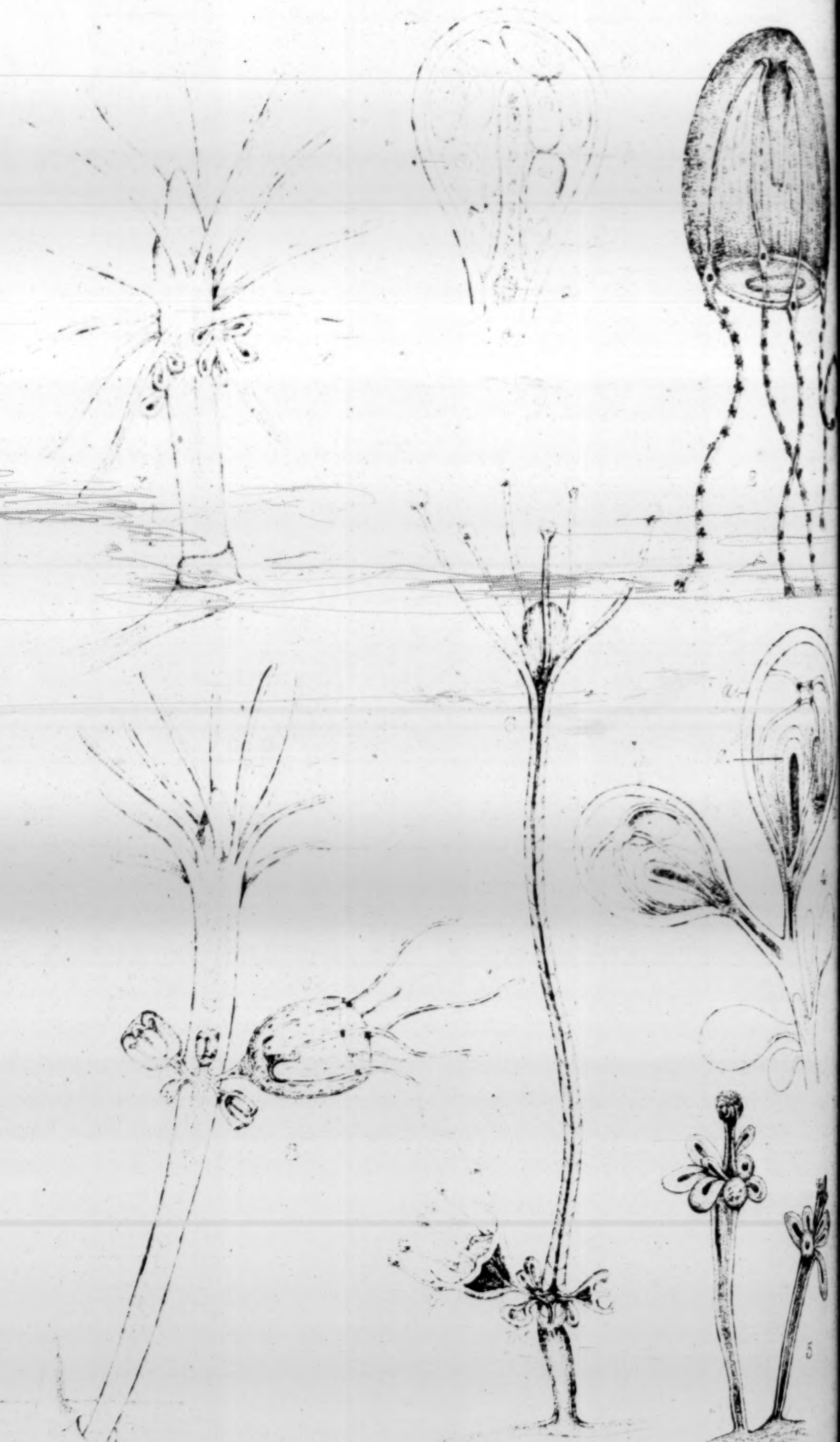
In No. CI., for 1862, Professor Rood describes his spectroscope with four prisms, three of bisulphide of carbon and one of flint glass. He points out a method of avoiding the curvature of the plane glass sides of such prisms, by covering each with a second plane and parallel sided plate, a few drops of olive oil being placed between. With this spectroscope, he found two new lines in the interior of the line D, making three fine lines enclosed in that double line.

In No. CV., for 1863, he points out the advantages of the bisulphide of carbon prism, as compared with the flint prism, an instrument by Merz, the sum of whose refracting angles was 270°, being unable to resolve the line D as completely as one consisting of three bisulphide of carbon prisms of 60° and one flint of 45°, though the sum of the refracting angles was 45° greater. He also insists on the advantage of large aperture.

Professor Cooke's Experiments.—In 'Silliman's Journal,' No. CI., for 1862, the prism made for Professor Cooke, by Clark, is described. It is built up of several thicknesses of plate glass, cemented together with Canada balsam. He describes its defining power, and the appearances presented by the orange band of strontium. It consists of an orange space covered by a large number of black lines, similar to those of Fraunhofer.

In No. CVII., for 1863, Professor Cooke describes a spectroscope, the largest made up to that time. It has nine prisms of bisulphide of carbon, giving 2¼ inches aperture, with telescopes of corresponding size. The prisms are made on Rood's plan. The instrument has established the following points:—1st. That the lines of the solar spectrum are innumerable; it shows at least ten times as many as are given by Kirchhoff, with very many nebulous bands on the point of being resolved; the line D consists of nine lines, and a nebulous band. 2nd. That the coincidences of the bright lines of metallic spectra, and the dark lines of the solar spectrum, remain perfect even with this increased power. 3rd. That many of the bands of metallic spectra are broad-coloured spaces, crossed by bright lines. This is the case with the orange band of strontium, and with the whole of the calcium and barium spectra.

Messrs. Johnston and Allen's Experiments.—In No. CIII. of 'Silliman's Journal,' for 1863, they describe the spectrum of cæsium,



T. Hincks, del. Hanhart, Imp^t E.M. Williams, F.L.S

TYPICAL ZOOPHYTES & THEIR DEVELOPMENT. (Plate I.)

finding it to yield eighteen lines instead of eleven. They also point out that some of Kirchhoff's lines are incorrectly mapped. The cæsium was prepared with the greatest care by precipitation from bitartrate of cæsium, with bichloride of platinum.

Professor Gibbs' Spectroscope.—'Silliman's Journal,' No. CIII., for 1863.—In this instrument, the prism has a refracting angle of only 37°. The rays fall on the first surface perpendicularly, and escape almost parallel to the second. The dispersion is very great, while the loss by reflection at the first surface in prisms of 60°, placed at the angle of minimum deviation, is avoided. Though the telescopes are only of 6 inches focal length, with a magnifying power of 6, it compares favourably with a large apparatus of 18 inches focal length, and 1½ inch aperture. This form of prism was first employed by Mathiessen, and if the first surface is made concave, so as to admit the addition of a double convex of crown, it would present great advantages in consequence of the saving of light.

ZOOPHYTES: THE HISTORY OF THEIR DEVELOPMENT.

By the Rev. THOMAS HINCKS, B.A.

THE remarkable facts which have been brought to light of late years respecting the reproduction of the Hydroid Zoophytes,—an Order of compound, plant-like animals, chiefly marine, of which the Hydra is the type,—facts which at first sight seemed little short of marvellous, and of which we have had so many speculative interpretations, have attracted notice even beyond the ranks of professed naturalists, and have formed the staple of many a scientific romance in the pages of our popular literature. Many who have but a smattering of zoological knowledge will have heard the story, that certain Zoophytes produce offspring totally unlike themselves—beings of dissimilar structure and habit, and that these reproduce the likeness of the original stock; they will have read with wonder, how the stationary, plant-like animal gives birth to a mercurial brood of restless rovers, and that there is a close blood-relationship between the polype and the Medusa. The celebrated theory of the "alternation of generations" may also have interested them as a curious speculation. But as yet the popular apprehension of the whole subject is probably of the vaguest and most inaccurate. It takes the form of a general notion that there are creatures which have not a feature of resemblance to their own fathers or mothers, nor yet to their own children, but which *do* resemble their grandfathers and grandmothers, which exhibit, in short, a complete reversal of the ordinary laws of kindred. The story as thus rendered has certainly enough of marvel and mystery about it to fascinate the mind; but we venture to think that the simple truth of Nature, as now placed before us, through the concurrent labours of many observers, is not less attractive, and we propose, apart from all technicalities, to give an outline of the later views of the reproduction and development of the *Hydroida*, and to supply the rationale of the facts, which have been made the basis of so much ingenious theory.

Before proceeding, however, to sketch the general characteristics of the group under consideration, we wish to draw attention to the very gradual accumulation of the facts on which our present theoretic views rest, and the way in which we have been led on from point to point by the observations of isolated students, until at length we have attained a true conception of the entire history. In a series of papers by various authors, extending over a considerable period of time, and scattered through the Scientific Journals of Europe and America, are to be found the successive steps by which we have advanced to the point at which the true method of nature was recognized. Some of these, of course, stand out from the crowd, as of pre-eminent merit. But we are anxious to direct attention to the valuable co-operation of those who have conscientiously put on record facts the full significance of which they did not at the time appreciate, but which have formed important links in the chain of evidence, by which the truth has been finally established. In interpreting the reproductive history of the Hydroid Zoophytes, we have been indebted to the suggestive observations of a large number of independent workers for the hints which have guided us into the right track. Gradually a series of facts has been accumulated, the significance of which was only partially, if at all, appreciated at first, but which now supply the basis of a complete and satisfactory theory.

We would commend to those who may have a taste for Natural History, and fair qualifications and opportunities for the pursuit of it, but who may not aspire to any very profound acquaintance with it in its large extent, the careful and conscientious study of single life-histories, as fraught with the highest interest in itself, and almost sure to yield valuable results. In the history of zoophytology, there are names which find an honourable place, and are inseparably connected with its progress, by virtue of one or two observations of undoubted accuracy and striking significance; and amongst the many species of Hydroids, which have not yet been followed through the various stages of their development, there is still ample room for that quiet and patient investigation which is within the range of so many, which is so rich in interest, and which has already done so much for the advancement of the science.

Animal-plant (Zoophyte) is not, after all, a bad popular name for the fixed, compound, and arborescent beings, in which so many of the characteristics of the two great kingdoms of nature are curiously blended. The Zoophyte is an animal in which the vegetative life is altogether predominant, which in its perfect state is commonly as stationary as the tree, and in a large proportion of cases imitates the form and general arrangement of parts that belong to the plant. The compound kinds which often attain a very large growth and are so remarkable for their beauty, are the result, like the tree, of a continued process of gemmation, bud after bud evolving itself and helping to build up the vital structure according to the pattern of the particular species. Throughout this tribe, we meet with the tendency to an indefinite repetition of similar parts, which is characteristic of the vegetable kingdom, and invariably marks a low grade of animal being.

In the history of the Order to which this paper is more specially devoted, the *Hydroida*, or Hydroid Zoophytes, there are facts which exhibit a still further parallelism to certain phenomena of vegetable life. The plant has its leaf-buds and its flower-buds: the one connected with the nutritive, the other with the reproductive, functions, distinct in structure, form, and position. And the analogues of these exist in the Zoophyte, which not only puts forth its multitude of polypites to secure and prepare food for the commonwealth, but also originates another class of buds, wherein the reproductive bodies are matured, which perpetuate and diffuse the species.

Whilst, therefore, the two organisms belong to distinct kingdoms of Nature, they are connected not merely by similarity of external aspect, but by a certain analogy of life. And some of the most remarkable and perplexing points in the history of the *Hydroida* may be best explained, by collating them with the familiar facts of the vegetable world.*

To gain a clear conception of the structure of the Hydroid Zoophytes, we must start from the common Hydra, the simplest element in the life-series to which they belong. In this historic animal, we have an epitome of the essential characters of the Order: in its life, we have the story of that Order "writ small." It presents us with a gelatinous body of mutable form, the centre of which is pierced by a cavity extending from end to end of it, that communicates at one extremity with the external world through a simple orifice, while at the opposite pole a somewhat expanded disc fulfils the contrasted functions of attachment and locomotion. The terminal mouth is encircled by a number of delicate and extensile threads, which bristle with an armature of minute but fatal weapons (thread-cells) and serve at once for the capture and destruction of prey. This simple structure, submitted to analysis, declares itself to be composed of two essential elements, which enter into every portion of it, and of which its few special organs are but modifications. Two membranes, an outer and an inner—the one in relation with the external, the other with the internal world—constitute the material out of which the Hydra, and all the kindred Hydroids, are wrought. The body is, as it were, a double sac, of which the arms that form a wreath round the orifice, are but tubular prolongations. The double membrane is the basis of Hydroid structure.

The provision for the multiplication of the species is twofold. New individuals are produced in immense abundance by a purely vegetative process. From the surface of the body, just as from the stem of the plant, buds pullulate, and these are rapidly developed into Hydræ, which are perfect copies of the original stock. During the process of gemmation, and before the termination of the organic connection between the nascent young and the parent, a composite being is formed, and we have thus in a transient stage of the life-history of the Hydra, a representation of that which is the permanent condition of most of the Hydroid Zoophytes. At a certain point of development, the budding Hydræ detach themselves, and enter upon independent existence.

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* In his 'Métamorphoses de l'Homme et des Animaux,' chapter xxii., M. de Quatrefages has drawn an elaborate parallel between the structure and reproductive history of the plant and the Zoophyte.

Let us examine the *bud* in its earliest condition, when it appears as a slight excrescence on the side of the body. It is a mere bulging of the double membrane, which forms the wall of the central cavity, a little *cul-de-sac* projecting from its surface, and freely communicating with the interior. This minute, sac-like extension of the two layers is gradually moulded into a perfect Hydra.

But besides the multiplication of this species by means of a gemmiparous process, strictly analogous to the phenomena of vegetable growth, we find also a true sexual reproduction. At certain seasons only, and within certain definite zones on the surface of the body, other buds are produced, which instead of taking the line of development just described, become laboratories wherein the generative elements are matured. These are the analogue of the flower-bud in the plant.

In essential structure they seem to be identical with the early stage of the Hydra-bud. They consist, like it, of a small sac, formed by an outgrowth of the body-wall—a cavity communicating with the stomach of the Hydra, and bounded by the double membrane. In the reproductive bud, however, growth is soon arrested, and it remains a small tubercle on the surface of the body. The generative products—ova or the male element—are developed within it, *between the two membranes*, which they push asunder as they increase in bulk.

Here, then, we have the simplest form of the reproductive system found amongst the Hydroida. But the point to which we would draw special attention is this: we have here the *essential element* of that system, under all the modifications which it presents throughout the Order. Whatever may be superadded, whatever accessory parts may be introduced, the ova and spermatozoa are produced universally within the walls of a body, which is essentially identical in structure and mode of growth with the simple reproductive pouch of the *Hydra*. The so-called Medusa is only such a pouch, somewhat modified, advanced a degree or two in development with a view to free existence, floated by means of a contractile bell, and supplied with a few rudimentary organs of sense.

A series of transition-forms, in which there are now no important gaps, links the simplest condition of the sexual zooid* with the most complex; the closed and stationary egg-bag at one extremity of the scale, with the free mercurial Medusoid at the other, which not only produces, but also distributes the ova.

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* This term is used to denote the several distinct elements, which make up the sum total of the individual life-series, *e.g.* the polypites, and the reproductive bodies, whether fixed or free.

We must emphasize this fact. The small bud on the surface of the Hydra's body, which discharges the office of ovary or spermary, is, to all appearance, identical in composition and manner of growth with the bud which is matured into a new individual, in its earliest stage. The Hydra-bud and the sexual-bud start from the same point, and travel together for a while on the same road; but the latter is arrested in its course, and adapted to a special function, while the former reaches the goal of separate individual existence. In other Zoophytes this reproductive bud makes a nearer approach to the Polypite form; and in the kinds which originate free Medusoids, it is even furnished with a mouth of its own, to which prehensile appendages are often attached, and a distinct nutritive system. It is, in fact, in such cases a sexual Polypite, with accessory locomotive organs. Of the *animal plant*, we may well call it the floating flower-bud.

The Hydra is a free and solitary being, and of the simplest structure. Its gemmæ are cast off successively, and prolific as it may be, it is still permanently single. But in other members of its tribe, the budding process has a very different result, a result similar to that with which we are so familiar in the plant. The gemmæ are retained in connection with the original stock, which is itself fixed, and a compound structure is formed, a commonwealth of Hydræ, indissolubly united like the leaf-buds of the tree, and partners in the same life. In these composite Hydroids, a slight modification of the essential elements, as found in the Hydra, produces a very important change in external aspect. The outer membrane excretes a horny covering, that clothes and protects, more or less completely, the soft portions, investing the stems and branches of the arborescent kinds, and in some families expanding into graceful calycles around the associated Hydræ, into which they can retreat for shelter. It is by this covering or polypary that the Zoophytes are best known, for in our museums they are commonly represented solely by the chitinous casts of their elegant and exquisitely-ramified forms.

The compound and plant-like growths, evolved by repeated buddings from a single germ, are often of very considerable size, some thousands of polypites being in some cases united in the one organism, each of which is actively engaged in the capture of prey for the nutrition of the commonwealth. The beauty of these vegetating animals is surpassingly great. They take the form of exquisite plumes, of miniature trees laden with polypites, like milk-white blossoms (which Marsigli took them to be), of clusters of tubes surmounted by vividly-coloured heads, encircled by a double wreath of tentacles, and looking like bright flowers on long and slender stems, of twisted pedicles bearing crystal chalices aloft, in each of which a Hydra displays itself, and casts forth its embossed arms over the crenated border, of a delicate netted stolon creeping over the surface of the sea-weed, and sending up at intervals tiny campanulate cells, fit to be the drinking-cups of fairies. Great is the variety, and great the beauty. But whatever may be the form or size of the Zoophyte, whether its federation number tens or thousands, it has its origin in a single Hydra, and is the result of a continued process of gemmation. Nutriment is procured for the commonwealth by the labours of the multitudinous polypites, is prepared in their stomachs, as in so many laboratories, and is then distributed to all parts of the structure, through a channel which permeates the trunk and every branch and branchlet. So much may suffice as a sketch of the general character of the tribe. Our present concern is with the reproductive history in which the facts occur that may be said to have a popular interest.

If we were in search of a complete contrast to the staid and stationary Zoophyte in external appearance and in mode of life, we might find it in those exquisite little crystal globes, which, bright and frail as the bubble, dance so gaily through the waters of the sea, and are known to the naturalist as Medusæ. On casual inspection, the two organisms seem to have nothing in common. The one is rooted to a point of space, the other is free of the wide waters, and seems almost to have realized perpetual motion. The one is all but universally compound, the other single. But why speak of differences, when there is not a point of apparent resemblance? Systematists till recently never dreamt of any connection between them, but grouped them in two distinct *Classes*. The observations of Wagner, Sars, Dalyell, Steenstrup, and others which showed that certain Medusæ of the simpler or naked-eyed division are borne as buds on certain plant-like Zoophytes, and are in some sense the progeny of beings so unlike themselves, were a startling surprise. We are now familiar enough with the fact, but have only lately discovered its real significance.

We now know that a very large proportion of the so-called naked-eyed Medusæ, if not all of them, are at one period of their existence in organic connection with some Hydroid stock, from which they bud just as the polypites do, but from which they are also detached at a certain point of their development, and in their free state mature the elements essential to the reproduction of the species, scattering the embryos, the seed of new colonies, at a distance from the original settlement.

Now, to comprehend this history, we must do two things: 1st, we must discard any conceptions we may have formed of the Medusæ as independent organisms—as perfect animals; and, 2nd, we must recognize the essential structural identity of the polypite and the medusoid.

Professor Huxley long ago took exception to the term *Medusa*, as the designation of the free sexual zooid of the Zoophyte, rightly urging that it tended to perpetuate an erroneous view of its nature. It should have a name that expresses its relation to the life-series, of which it is but a single term, and that suggests no thought of positive independence. We believe that it will be better to dismiss both Medusa and Medusoid from our nomenclature, and thus to get rid of the false associations that have gathered round these terms as a nucleus. Professor Allman, to whom we are indebted for an exhaustive report on the reproductive history of the Hydroida, and whose name is identified with the most philosophical views of the subject, designates the body which gives origin to the generative elements, the *Gonophore.* For reasons with which we need not now trouble our readers, we prefer the term *Gono-zooid*—reproductive zooid—the element, that is, of the Zoophyte, whether fixed or free, which discharges the sexual functions, the equivalent of the flower-bud in the plant. Throughout the remainder of this paper we shall employ this term as thus defined, though by doing so, we shall discharge some of the romantic flavour from our story.

With respect to the second point, the structural identity of the nutritive and the sexual zooids, however different in external aspect, we shall hope to make it apparent in the course of the sketch of the reproductive history of the Zoophyte, which we shall now proceed to give.

We have already seen that in the case of the Hydra, as in that of the plant, two distinct classes of bud are developed, the one concerned in nutrition, the other in reproduction, and the same holds good of the Hydroid Zoophyte. Besides its multitude of busy polypites collecting food, and with no other function, bodies are met with at certain seasons of peculiar structure, which exhibit a true sexual character, and, as Quatrefages puts it, "à qui seuls revient le soin d'assurer la propagation de l'espèce." These reproductive buds present many varieties,—they have their many forms and even colours, like the flower and fruit of the plant,—and they differ yet further and more remarkably in this, that while some of them continue permanently attached to the stock, others, at a certain stage, become free. The latter disguised by the locomotive organs, with which they are furnished for the vagrant term of their existence, and long known to the naturalist, apart from all their connections, are *the Naked-eyed Medusæ* of authors (Plate i. fig. 2). We must not, however, draw too broad a line of distinction between the fixed and the free reproductive zooids. They are both portions of a series, through which indeed "one increasing purpose runs," but also an identity of essential elements.

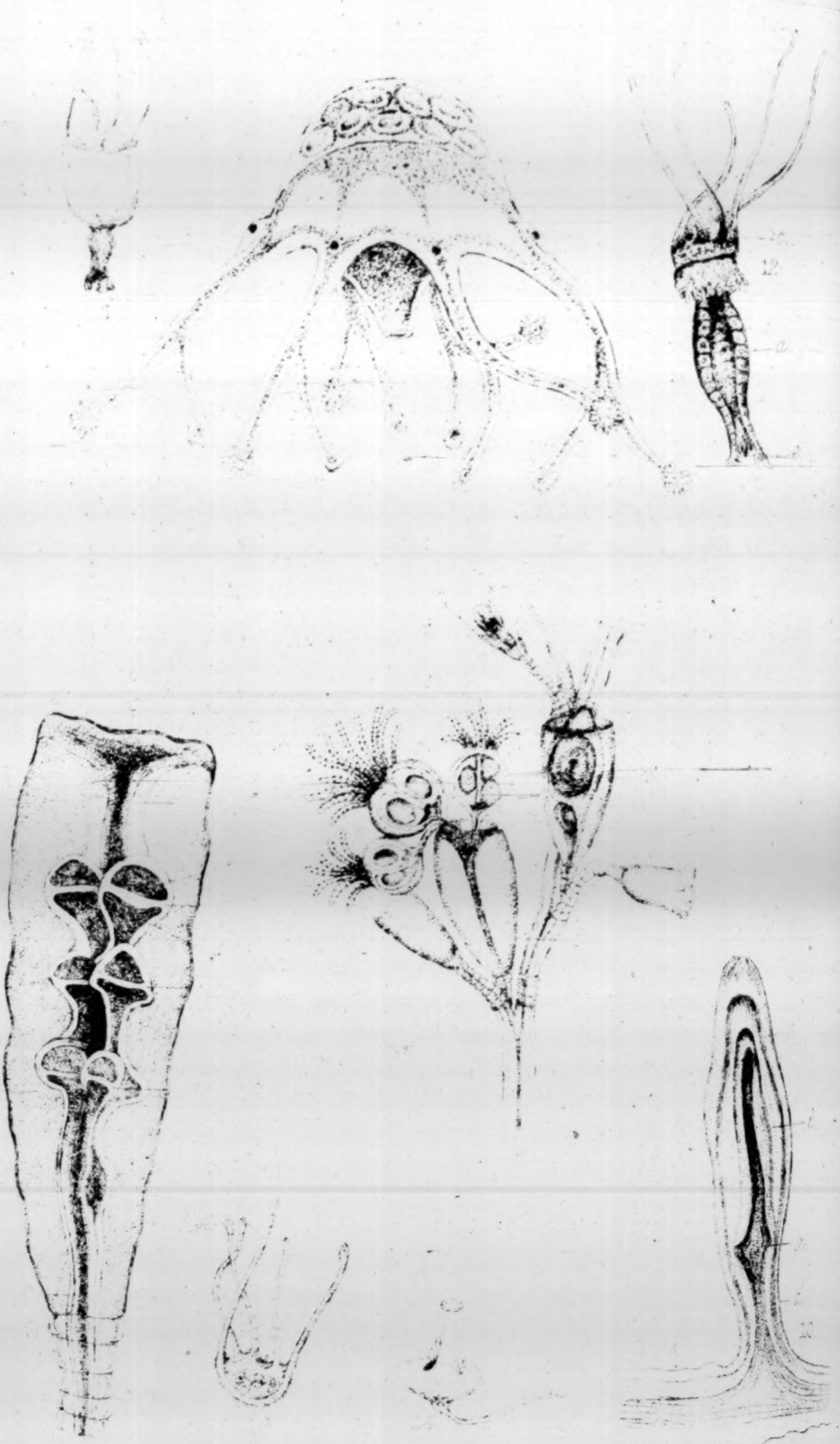
The fixed sexual bud of the Zoophyte matures and discharges its contents *in situ.* The free zooid, liberated from the parent stock, bears with it the seed of new commonwealths, and colonizes distant seas.

Let us trace the history of these bodies. They are produced on various parts of the Zoophyte. Sometimes they bud from the ordinary polypite and form a kind of collar near the base of its tentacles (Plate i. fig. 1). Sometimes they occur near the lower extremity of the body, pullulating in opposite clusters (Plate i. fig. 6).

In some cases, a partially-developed polypite, one in which growth has been more or less arrested, supports the reproductive zooids (Plate i. fig. 5). Sometimes the atrophy shows itself merely in a reduced number of tentacles; sometimes the arms disappear altogether, as in the *Hydractinia* (Plate i. fig. 5); sometimes it sets in only as the sexual buds approach maturity, and a greater drain takes place upon the nutritive energies in their behalf, as we have seen it in *Coryne.* In other cases, both mouth and arms are suppressed, and the reproductive bodies bud from the sides of a simple off-shoot from the common trunk. This condition obtains almost universally amongst the Campanularian and Sertularian Zoophytes, and in these tribes the fruit-bearing shoot traverses the centre of a horny capsule, which envelopes and protects the whole brood of sexual zooids, as the ordinary calycle shelters the polypite. In Plate ii. fig. 9, we have a representation of the reproductive capsule of a Campanularian Hydroid (*Laomedea amphora*, Agassiz). The horny envelope (*a a*) is supported on a short ringed pedicle (*b*), by which it is attached to the Zoophyte at the base of the longer stalks, which bear the cells of the polypites (*Hydro-thecæ*). From one extremity of the capsule to the other passes the off-shoot (*c c*) from the common pulp, on which the reproductive buds or zooids are borne (*d*). This shoot is plainly a Hydra, arrested in its development before the formation of a mouth and tentacles, and dependent for food on the supplies which are brought to it by the general nutritive stream, which circulates, like the water through a town, to every part of the colony, and which enters it through an orifice at the base. It would appear, in some cases, to declare its essential nature by developing the missing parts and assuming the perfect polypite form, when the reproductive bodies have run their course and discharged their contents. Ellis at least figures Hydræ protruding from the capsules of *Sertularia pumila*, and we have had no more trustworthy observer. For this imperfect polypite, whether naked, as in the *Hydractinia* (Plate i. fig. 5), or enclosed, as in the case before us, a special name has been invented, and in conformity with the present unhappy fashion, it is a Greek compound of six syllables—*Gonoblastidium*, or in a mitigated form, *Blastostyle !* We venture to protest against this infliction, as both unnecessary and in some degree deceptive. The mouthful of Greek, which may well set the teeth of the young or unlearned naturalist on edge, is more likely to divert attention from the real significance of the body in question than to help the student to interpret it aright. Who would venture to recognize a familiar friend in a Gonoblastidium ? In fact, it is a fertile polypite—a Hydra which bears the sexual buds, and is somewhat enfeebled by the work,—and why, in the name of common sense, should this intelligible designation be translated into Greek or any other learned language ?

The reproductive buds are also developed, in some species, on the stem and branches, and rarely on the creeping stolon, which originates and unites the several shoots that compose the Zoophyte.

And now a word as to the nature of the buds themselves. In the first place, they are male and female—one set giving rise to the ova, and another to the spermatozoa. Sometimes the two sexes are borne on the same colony ; sometimes, and more commonly, the male and female zooids occur on separate colonies. The Zoophyte, like the plant, is diœcious or monœcious ; and the latter condition is of more frequent occurrence than has been supposed. Professor Allman gives one or two instances of it as strictly exceptional, but we have met



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TYPICAL ZOOPHYTES & THEIR DEVELOPMENT (Plate II) with some other cases, and probably careful investigation might increase the number.*

In Plate i., fig. 1*a*, we have a good illustration of one of the simplest forms which the reproductive bud of the Zoophyte assumes. It is a highly magnified representation of one of the bodies that are shown *in situ* in Figure 1 (x—x), and it is at once apparent that it exhibits a very slight advance upon the simple egg-pouch of the Hydra. It is a narrow sac, formed by an outgrowth of the body-wall. The central cavity (*a*) is in free communication with the stomach of the polypite, and is visited by the common nutrient stream. It is enclosed by the inner of the two membranes (*b*), that we have described as the basis of all Hydroid structure, from which the outer (*c*) is separated by a mass of ova. Essentially this is the sexual bud of the Hydra over again. The latter, indeed, is of small dimensions, and contains but a single ovum, which, as it enlarges, soon presses down the inner membrane, and obliterates the central cavity, but the component elements are the same in both. The differences between them are of very slight significance. They amount to nothing more than this, that in the present case, the external membrane is divided into two layers, the outermost of which serves as a protective capsule (d—d), and the bud is elevated on a kind of pedicle. To convert this Gono-zooid into a *polypite*, little change would be needed. With an orifice at the upper extremity, and a few tubular prolongations of the sac around it, or scattered over the surface, and *minus* its capsular investment, it would be a very respectable Hydra. Before the differentiation of the ova, it is all but identical with a polypite-bud in its early stage.

In the Campanularian capsule (Plate ii. fig. 9), the sexual zooids (d—d) are of a still simpler character, and make a yet nearer approach to those of the Hydra. Each of them contains only a single ovum (*e*), which, as it increases in size, occupies nearly the whole of the sac, the inner wall (*e*) being pressed down towards the bottom of it, and forming "a shallow, saucer-shaped basis for the egg." In the male zooid, however, the central cavity is large, and projects far into the enveloping mass of spermatozoa. The sexual bud of the Hydra is in all these points identical with that of the Campanularian† before us, which Agassiz describes as "nothing more than a double-walled hernia;" and yet, from the capsules of a Zoophyte nearly allied to this, of much the same structure and general aspect, we may witness the escape of those Medusa-like organisms to which so much interest has attached. So that within the limits of a single family, and in its most nearly allied species, we find the most widely-separated forms, the simplest and the most complex, of the reproductive zooid.

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* We have met with male and female capsules together, on *Halicornaria* (*Plumularia*) *Catherina*, on which they are thoroughly intermingled; *Sertularia tamarisca* and *S. fallax*, and (we believe) on a species of *Halecium*. The *Hydra* presents us with both conditions, being sometimes monœcious, and sometimes diœcious, representing its Order in this, as in so many other points.

† *Vide* a paper by Hancock, "On a species of Hydra found in the Northumberland Lakes." Ann. Nat. Hist., vol. v., 1850.

It is our business now briefly to trace the connection between the two—to show that the one extremity of the scale is united to the other by a series of intermediary forms, and *that there is the same essential element in all.* We have to link the fixed bud that vegetates and liberates its germs, and then withers away on the spot, where it came into being, to the winged and freighted seed-vessel, floating far and wide through the waters.

Let us pass then at once to the free Gono-zooid (the *quondam* Medusa), and examine its structure. We have a representation of it, while still attached to the Hydroid stock (Plate i. fig. 3*a*); and after liberation (Plate i. fig. 2). In its former state, it is connected by a pedicle with the body of the polypite, which springs from the midst of a cluster of buds in various stages of development. We might naturally take it to be a permanent portion of the colony, a bud of peculiar structure, and destined for some special function, but not more remarkable amongst the polypites than the flower-bud amongst the leaves on the plant. Such, however, is not its history. After a while it dissolves its connection with the polypite, and thenceforth leads an independent existence. By a reference to Plate i. fig. 2, the reader will obtain an idea of the general form and structure of the free Medusiform zooid. A somewhat globose and transparent disc floats gracefully in the water, and within the cavity a cylindrical body hangs from the central point of the dome—a rose-coloured pendant in a crystal sphere. The disc or umbrella is truncate below and partially closed by a filmy membrane or veil, in the centre of which there is an oblong aperture. From its margin depend four extensile and beaded tentacles, which take their origin in as many bulbs, on each of which a rose-coloured ocellus glitters. From the base of the pendant body four tubular canals pass through the substance of the disc to these bulbs, where they join a circular vessel that runs round the margin, and connects them all. The disc, which is the striking feature of the structure, is a float and swimming bell, and by means of its rhythmical contractions the zooid is jerked backwards through the water. The pendant body is furnished with an orifice at its free extremity (the mouth), which admits to a central cavity, and this communicates at the base with the four canals, and through them with the circular, marginal vessel. We have here the nutritive and circulatory systems. The tentacles are fishing-lines, and the *ocelli*, it may be, rudimentary light-perceiving organs.

In time ova or spermatozoa, as the case may be, are developed *between the two membranes* which constitute the walls of the pendant body (Plate ii. fig. 12*a*)* and when these are matured and discharged, the zooid having fulfilled its functions appears soon to perish.

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* This figure represents the pendant portion of a Gono-zooid apart from the swimming-bell, with the ova developed in the walls. It is proper to mention here that in certain families the generative elements are not produced in this situation, but in small sacs, which bud from the radiating canals. These canals, however, we must remember, are but prolongations of the central cavity, so that the reproductive bodies are still in connection with (essentially) the same portion of the structure. The difference is that in this case instead of lying between the two layers which compose the wall of the canal, the generative products are contained in sacs, which bud from them, and which are similar in structure to those of the *Hydra*.

This sketch may suffice to give an idea of the *plan of structure* which characterizes this class of buds. Of course there are many diversities. The colours, the form of the disc, the number of the canals, the shape of the pendant, the number and structure of the tentacles, all these vary, while in some species there are additional organs of sense on the margin. But the plan of structure is constant.

To describe the several parts of these animated seed-vessels is an easy task, but it requires the pencil of the artist and the pen of the poet to do full justice to their beauty. Let any one who would realize it glance over the plates in Professor E. Forbes's Monograph on the (so-called) "Naked-eyed Medusæ." He brought the skill of the artist, and the fancy of the poet to the illustration of their history, and he has well epitomized their characteristics in saying that "they are active in their habits, graceful in their motions, gay in their colouring, delicate as the finest membrane, and transparent as the purest crystal."

Now at first sight, these floating bodies seem to have little in common with the fixed buds which we found discharging a similar function on the side of the Hydra, and within the reproductive capsule of the Campanularian.

But if we put out of view for the moment the portions of structure which have immediate relation to independent existence, the swimming-bell and its appendages, we shall have as the residuum a body which is essentially identical with these buds. The central pendant of the Medusiform zoid is represented in this condition in Plate ii. fig. 12—the disc having collapsed, and the remains of it (*b*) with the tentacles attached, hanging from the base of it. The disguise being thus got rid of, we recognize at once the structure with which we are already familiar—a bud presenting a central cavity (*d*) enclosed by the two membranes, between which ova are developed. True there is an opening at the extremity (*e*), but this also is connected with the necessities of free existence, the zooid being dependent in this stage of its being on supplies from without, and no longer nourished by the commonwealth. Suppress the mouth, and the body which we are examining is identical (essentially) with the sexual bud of the *Hydra*, of the *Clava* (Plate i. fig. 1*a*), *minus* the protective envelope (*d*), and of the *Campanularian* (Plate ii. fig. 8*d*.)

The accessory and adaptive organs then, which fit the sexual bud in some cases for a term of free existence, constitute the difference between its simpler and more complex forms. The ova- or sperm-bearing body, which is the essential element, is constant and structurally identical throughout the Hydroid series. In the case of the Medusiform zooid it exhibits an advance of development, is furnished with a mouth, and becomes a true polypite, a polypite combining the nutritive and reproductive functions. The (so-called) Medusa is a sexual Hydra (male or female), suspended within a contractile bell, which bears it through the water. The vivid tints which it often displays both on the disc and the peduncle, the gracefulness of its forms, and the exquisite delicacy of its tissues may well remind us of the flower of the plant, with its painted petals, and campanulate corolla, and central mass of colour; and if the flower-bud were in any case set free to float in the air, and there distribute the seeds matured in its ovary, it would be the exact analogue of the locomotive bud of the zoophyte.

A study of the earlier stages in the development of this body will confirm the view which we have given of its nature. It is at first an outgrowth of the body-wall, an extension of the two membranes, including a small sac-like cavity. It is identical with a Hydra-bud. The outer layer, as we have seen in the case of *Clava*, divides, and an external covering is formed, within which the development of the bud proceeds (Plate i. fig. 3*b*). We shall not follow in detail the changes which supervene, but merely state generally, that the same layer is again split into two, and that the bud instead of continuing simple, and maturing and discharging its products *in situ*, is invested by the membranous envelope thus formed, which becomes the swimming-bell in time, and at length bears it from the stock. When the bud has reached a certain point of development, its outer enveloping sac is ruptured, and it bursts, as it were, into flower; the Gono-zooid now nearly perfect, and ready for freedom, hangs on its slender pedicle (Plate i. fig 3*a*), until by the vigorous contractions of the disc the frail bond is severed and it floats away.

To complete this portion of our subject, it is only needful to pass in rapid review some of the intermediate forms or conditions of the reproductive zooid, which connect the two extremities of the developmental scale.

(1.) It sometimes takes on the contractile swimming-bell, and to all appearance is on the usual road to separate existence, but is arrested before reaching the goal, and remains a *fixed* Medusiform bud. The central peduncle behaves like any simple reproductive sac, and discharges its products, where it is. In such cases the tentacles are rudimentary, and the mouth also, if present at all.*

(2.) A somewhat lower stage is met with in the common *Tubularia indivisa* of our coasts. In this zoophyte the sexual bud (Plate ii. fig. 4) is permanently attached, but it is furnished with the umbrella (*b*) in which the canals are present, and the orifice, with four tubercles, representing the four marginal tentacles. The generative sac (*c*) destitute of a mouth occupies the centre. There is every preparation for free existence up to a certain point, but the bud remains to the end packed up in the outer sac (*a*) and the swimming-bell is converted into a chamber or nursery, in which the embryo (*d*) completes its development, escaping at last through the orifice above.

(3.) In the remarkable Campanularian Zoophyte the *Gonothyræa Lovéni*, Allman (Plate ii. fig. 8), we have another modification of the process. The figure represents a portion of a shoot, on which both polypite-cells and reproductive capsules are present. In one of the former (*a*) the Hydra is seen retracted within its transparent dwelling. *b* and *d* are two of the *Gono-thecæ*—the horny receptacles within which the sexual buds are developed, as in Fig. 9. At *d* one of them is represented within the capsule, attached to the axial column, which we have before described, as an imperfectly developed polypite. While in this position it exhibits the central reproductive sac (*the essential element*), surrounded by two investments, the inner representing the swimming-bell, with canals and an orifice, and a number of tentacles, but no contractility, the outer being the usual protective case. The generative elements are produced between the walls of the sac—but the ova, at least, soon rupture the outer one, and complete their course of development within the more spacious area of the swimming-bell. But there is this peculiarity in the history of the sexual buds of this species,—at a certain stage they are pushed out beyond the mouth of the capsule, where they hang like fruit (Plate ii. fig. 8, *c*, *c*, *c*), until the seed has ripened and escaped, when they wither away.

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* Lovén first described this form in his famous paper, entitled 'Bidrag till kännedomen af Slägtena Campanularia och Syncoryna,' published in 1836; and he speaks of the peduncle in his *Syncoryna ramosa*, as possessing "an exceedingly small mouth,"—"*en ganska liten munn omgifven af omkring tio smä tuberkler—rudimenter till munntentakler.*"

(4.) In yet another case, Prof. Allman has detected in a sexual bud like that of *Clava* (Plate i. fig. 1*a*) in most respects, the membrane which represents the swimming-bell interposed between *d* & *c*, but forming merely a closed sac—one more envelope around the ovary—while at its base (a clue to its real significance) are the rudiments, the beginnings of four tubular canals. From this point a single step carries us to the simplest form of bud—*the polypite body*, slightly modified, which bears in its walls the sperm or the ova.

We must not omit to mention that the free Gono zooid, though parting from the parent stock and renouncing its stationary life, retains the vegetative tendencies of its tribe, and, in many cases at least, multiplies itself by budding. Its buds, indeed, are cast off like those of the Hydra, as becomes a free being, but it preserves the customs of its race.

Our sketch of the reproductive history of the Hydroida would be incomplete, if we did not add some further illustration of the structural identity of the nutritive Zooid—the Polypite, and the Gono-zooid. Different as they are in external aspect, they are fundamentally the same. This has been partially apparent in the course of our review of the various grades of the sexual bud. We have easily recognized *in the generative sac* the equivalent of *the body of the polypite.* But we owe it to Prof. Allman's keen insight into homological relations, that we can also identify *the radiating canals*, with *the tentacles of the polypite*, and so complete our interpretation of the reproductive zooid. He reminds us that the tentacles are tubular prolongations of the central cavity of the Hydra, just as the canals are of the peduncle of the Gono-zooid, and that we have only to suppose them to be united for a portion of their length by a membrane,* the remaining portion hanging free beyond its margin, to have a structure essentially identical with that of the so-called Medusa. This membrane is a growth from the outer of the two fundamental layers of the body-wall and is contractile, when the zooid is to be locomotive. It constitutes a web uniting the tentacular canals, and thus forming a somewhat campanulate disc, while an extension of its margin gives rise to the veil, which partially closes the swimming-bell below. *The portion of the body of the polypite in advance of the tentacles* is the equivalent *of the generative sac* of the Gono-zooid.

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* The tentacles of the Polypite are actually thus united in one or two species of Hydroid.

We have no intention of troubling our readers with the evidence in detail on which this view rests; but would merely state, that it is sustained by a careful examination of the development of the Gono-zooid, and by many collateral proofs. The generalization to which we are led will have more popular interest. It is this: the reproductive zooid of the Hydroid is in all cases a modified polypite. In its simplest condition it is a polypite without mouth or tentacles; in its highest, it is a polypite with both,—the tentacles, however, being adapted to the formation of a nutritive and locomotive system, with a view to free existence. The two extremes are connected by a multitude of intermediate forms. The so-called Medusa is a sexual polypite, with its arms webbed for floating and swimming.

A very interesting connecting link between the nutritive and sexual bodies in the Hydroid commonwealth is found in the free Gono-zooid of the *Clavatella prolifera*, Hincks (Plate ii. fig. 7). A representation of the polypite of the *Clavatella* is given in Plate i. fig. 6. A cluster of the reproductive buds (*y*, *y*) is seen pullulating from a point near the base of it.

The Gono-zooid of *Clavatella*, though free and locomotive, is not furnished with a swimming-bell—or rather this organ is present only in a latent condition. It is a walker and climber, not a swimmer. It moves by means of sucking-discs attached to the extremity of a branch or fork of the arms (Plate ii. fig. 7*d*). The true tentacle terminates in an enlargement (*c*) which is thickly set with thread-cells. That the membrane which in other species constitutes a swimming-bell exists, we infer from the presence of the radiating canals,* which may be seen passing to the base of the arms (Plate ii. fig. 7). But it is not separated from the body, and is useless for locomotive purposes. As the zooid walks, the mouth (*b*) hangs downward, as it does in the swimming forms. At the base of each of the arms is an ocellus or eye-speck (*e*, *e*). We recognize, in short, in this form, a Medusiform zooid, without its swimming-bell, but with a compensation for the loss in the shape of suctorial feet. As readily do we recognize in it a polypite, with very slight modifications. Let the reader refer to Plate i. fig. 6, and compare the head of the *Clavatella* with its free zooid, and he will see at once that very little change is needed to convert the one into the other. Let him suppose the head to be detached at a point nearly opposite to Fig. 6, and the lower portion of the arms to be united by a membrane closely investing the base of the proboscis, and their upper portion to be furnished with a sucker-bearing fork, and he will have the sexual polypite. As we have remarked elsewhere,* there is the closest resemblance between the two, the arms of both "exhibiting the same number of opake-white patches, and in precisely the same positions." The Gono-zooid of *Clavatella* is an ambulatory polypite, with the simple circulatory system, and the eye-specks, which are needful to it as a free being.

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* These were first detected by Krohn. See Wiegmann's 'Archiv.' for 1861, p. 157.

Agassiz, in his great work on the 'Natural History of the United States,' describes the fixed reproductive bud of a Hydroid (*Rhizogeton fusiformis*, Agass.),† as being developed into a polypite, after completing its sexual functions, and he considers this the most direct evidence thus far obtained of the structural identity of the two bodies. (Vol. iv. p. 226.) Prof. Allman regards the phenomenon as abnormal; but even so, it is not the less important evidence.

One other class of facts may be mentioned in this connection. In some cases, at least, the Gono-zooid, after a term of free life, returns to a stationary condition before the liberation of the ova. The locomotive energy fails, the delicate swimming-bell is thrown back and turns inside out (Plate ii. fig. 11), gradually it collapses and shrinks up into a shapeless mass, hanging in this condition about the base of the body, with the tentacles streaming behind it (Plate ii. fig. 12). The disguise is now thrown aside, and the polypite remains, laden with ova (*a*). It continues quiescent until they are discharged, and after this fades away.

Dujardin describes the Gono-zooid of a species of *Stauridium*, as thus casting aside its locomotive apparatus when its course was nearly run, and resuming the sedentary habits of its tribe, and his observations have been confirmed by Mr. Holdsworth. We have seen the same thing in the case of a *Coryne* and of the *Podocoryne*, and Mr. Peach has reported to the like effect of the latter.‡ We believe it to be the normal course in these cases.

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* 'Annals of Nat. Hist.' for February, 1861.

† Plate ii. fig 10.

‡ Vid. Ann. Nat. Hist. (2nd ser.) vol. xviii., 1856, p. 99. Mr. Peach supposed that in this case the polypite was metamorphosed into the Medusoid. But there can be little doubt that this was an error. From an examination of his figures and description, we are convinced that he had a species of *Podocoryne* before him, closely allied to *P. carnea*, if not identical with it, the four leaf-like appendages on which delicate arms were sometimes seen, being the attached Gono-zooids, and the four filiform appendages, the tentacles, which are often few in number, on the prolific polypites. In the case referred to in the text as having come under our own observation, the Gono-zooid did not perish even after the liberation of the ova and the disappearance of the peduncle.

The remains of the swimming bell (pl. ii. fig. 12 b) sloughed away and the bulbous bases of the tentacles (*c*) were fused into a single mass, of hemispherical form, and orange colour, around which an ectodermal covering formed (pl. ii. fig. 13 c). The specimens continued free in this condition for a time, the arms being in frequent motion. At last some of them became attached by the base, round the edge of which a thin rim of transparent matter appeared, most of the arms withered away, and in one or two instances an ascending shoot sprouted in the centre of the orange disc (Pl. ii. fig. 14). Further than this, we were unable to follow their

We have thus passed in review the various elements of the Hydroid life-series, and endeavoured to supply their interpretation, and to exhibit their mutual relations. We have traced the sexual bud from its simplest to its most complex form, distinguished between its essential and accessory parts, and shown that it is in all cases a polypite structure modified for the special reproductive office. We have collated the nutritive and sexual zooids, and shown that even the so-called Medusa, unlike as it looks, is structurally identical with the polypite, the elements of which are adapted in it to subserve a different function. And we have sought and found a key to many of the most remarkable passages of the history in the analogies of the vegetable world.

And if some of the *marvel* has seemed to vanish as we have proceeded, we venture to think that the real romance of Nature is more than an equivalent for the loss.

There must always be a certain fascination in a history which tells us of animals composed of multitudes of individuals (zooids) living an associated life, and so combining as to produce the most graceful, plant-like structures, vegetating like a tree, putting forth thousands of polypites like leaves, each a provider for the commonwealth,—putting forth also a company of buds charged with the perpetuation of the species, ripening in transparent urns, and scattering their winged seeds broadcast, or sent forth, moulded and painted by the highest art, like fairy emigrant ships, freighted with young life, to colonize distant seas. And these are the simple facts of Nature.

We have often had occasion in the course of this article to refer to Professor Allman's labours in this department of Natural History, and to the important contributions which he has made to our knowledge of the *Hydroida*. These it would be impossible to over-estimate. At the same time, we confess that some of the views propounded by our distinguished friend fail to satisfy us.

His classification of the Gono-zooids under two divisions, to which he has given Greek names, which we omit, lest the general reader should forswear our favourite science on the spot, appears to us unnecessary, if it be not misleading. The various modifications of the reproductive system pass one into another almost insensibly, and any line drawn to bisect the series must be purely arbitrary. To separate the more distinctly Medusan forms (so called) from the simpler is to run the risk of creating a false impression as to the relations between

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history; but to all appearance a polypite was in course of development. An account of these observations was presented to the Nat. Hist. Section of the Brit. Assoc. at the meeting for 1864.

Since the passage in the text was written we have seen a paper by Prof. Allman in the June No. of the Annals of N. H., in which he describes "the retrograde metamorphosis of the Medusa into the polypite," in the case of a new *Syncoryne*, which he has discovered in Scotland. Curiously enough the Gono-zooid of this species seems to be almost, if not absolutely, identical with that of the *Coryne eximia*, in which we had previously observed the same change, and which, in its turn, we have shown to be identical with that of the *Stauridium productum*. These facts would lead us to a very interesting chapter of the history, upon which, however, we have not space to enter at present.

the two classes. The boundary, on one side of which is found the Gono-zooid of *Tubularia indivisa*, with its fully-developed swimming-bell, exhibiting canals, an orifice, and even slight contractility, and on the other, the Gono-zooid of *Coryne gravata* (Wright), or *Syncoryna ramosa* (Lovén), with rudimentary mouth and tentacles, and which never becomes detached, can only be regarded as purely artificial. We believe that it is wiser in all respects to maintain unimpaired the continuity of the series, and not to break, for purposes of convenience or otherwise, the chain of links which connects the lowest form with the highest.*

Again, Professor Allman long ago enunciated the doctrine that the *fixed sexual buds* of the Hydroida possess in all cases "a true Medusal structure in a more or less degraded or disguised condition;" and in his recent report he lays it down that "the closed generative sac of a *Clava* (*vide* Plate i. fig. 1a), or a *Hydractinia* (Plate i. fig. 5), is an easily understood modification of a Medusa." But why this way of putting it? "*Medusal structure*" is modified polypite structure. The fundamental element, as it were, of the Hydroid life-series is the polypite, as the leaf of the life-series of the plant. It is this element which is "disguised" in some portions of the reproductive scale, and which it is at times somewhat difficult to recognize beneath its adaptive dress. We should reverse Professor Allman's proposition, and say that the (so-called) Medusa is a modification of the "closed generative sac of the *Clava*," or rather of the polypite, of which the latter is itself an adaptation. And instead of tracking "Medusal structure" amongst the disguises of the reproductive system, we should rather start from the simple element which constitutes the common base of the Hydroid organism, and trace the gradual evolution from it of the more complex forms which culminate in the free sexual zooid. With this view we most truly interpret the facts which are actually before us; for the polypite element is recognizable from one end of the series to the other, but the reproductive sacs of *Clava* and other Hydroids are without a trace of Medusan structure, and to say that this structure exists in them in "a degraded or disguised condition," really means no more than to say that the statue exists in a degraded or disguised condition in the block of marble. Professor Allman would recognize the "Medusal" element throughout the reproductive series; we, on the contrary, would rather recognize the polypite everywhere, and dropping altogether a term which *seems* at least to imply an essentially distinct mode of structure, we should say that the Gono-zooid of the Hydroid Zoophyte is a Hydra more or less modified for the discharge of the sexual functions—attaining in its highest form a free existence, and becoming locomotive by the conversion of its tentacles into a natatory organ.

The whole subject under many of its aspects is one which must have an interest for the general reader, though he may not be willing to undertake the study of a new language for the sake of it. It has been our simple object to translate the later views of the development of the Zoophytes out of technical phraseology and Greek compounds into as plain English as the subject will permit, and with such comment as our own studies might supply—*pro bono publico.*

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* Professor Huxley has taken the same view in his great work on the 'Oceanic Hydrozoa,' p. 137.

EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. A polypite of *Clava.* *x*, *x*, Clusters of reproductive buds.
Fig. 1a. The female generative Sac of *Clava*, highly magnified.
Fig. 2. The free Gono-zooid of *Coryne eximia.*
Fig. 3. *Podocoryne carnea*, Sars.
Fig. 4. Reproductive Sacs of *Tubularia indivisa.*
Fig. 5. *Hydractinia echinata*, Fleming,—fertile polypites.
Fig. 6. *Clavatella prolifera*, Hincks.

PLATE II.

Fig. 7. The ambulatory Gono-zooid of *Clavatella.* f, the ovary.
Fig. 8. *Gonothyrœa Lovéni*, Allman.
Fig. 9. The reproductive Capsule (*Gono-theca*) of *Laomedea amphora*, Agassiz. From the figure in the "Contributions to the Nat. Hist. of the U.S." Vol. iv. plate xxx.
Fig. 10. The fixed Gono-zooid of *Rhizogeton fusiformis*, Agassiz.
Figs. 11-14. Gono-zooid of *Podocoryne carnea.*

ON THE NEW RED SANDSTONE AS A SOURCE OF WATER SUPPLY FOR THE CENTRAL TOWNS OF ENGLAND.

By Edward Hull, B.A., F.G.S. Of the Geological Survey.

Those who are anywise acquainted with the internal economy of towns and cities in our small and densely-peopled Isle, are aware of the increasing importance of a permanent supply of good water. Session after session, corporations, companies, and commissioners come before Parliament for powers to carry out schemes of water-supply, not only for places already inhabited, but for those whose destiny as such, at no distant day, is clearly foreshadowed by the growth of the neighbouring town. Railways often cause the Fates to spin the wheel with unusual celerity—and the supply beforehand of abundance of pure water is an additional motive power—hence in a few years a houseless suburb becomes in itself a flourishing town.

In former times, even without going so far back as the days of Goldsmith, when there were such things as villages in the central parts of England, every large house had its well, and a mighty pump placed in the centre of the village supplied the wants of the poor. In other cases a gurgling brook ran by the houses, singing merrily—

> "Men may come, and men may go,
> But I go on for ever;"

and freely giving-of its waters for household use; but now that the villages have grown (or are growing) into towns, and towns into cities, whose inhabitants are counted by hundreds of thousands,—these ordinary sources of supply are becoming obsolete and useless from contamination; the brooks have been turned into pestiferous sewers—the wells have either dried up or become poisonous;—and the evil through generations of neglect has reached such gigantic proportions, that even Parliament refuses to deal with it.

Private companies, also, which have heretofore been depending to some extent on neighbouring streams, are now forced to extend the bounds of their area of collection to greater distances, or to sink wells, where the geological structure of the district will admit of them, to great depths, and apply powerful machinery. The Birmingham Water Company is a case in point. Hitherto the company have been deriving their supply from the brooks and wells, but this year they have found it necessary to come before Parliament and ask for powers to enable them to extend their area of collection. In his evidence, Mr. Hawksley, the consulting engineer of the company, stated that they were making provision, by the sinking of additional wells, for ultimately abandoning one of their present sources of supply—the tributaries of the river Tame, which there was every prospect would become unfit for drinking purposes, owing to the spread of buildings and factories in the neighbourhood.

Happily for the prosperity of our great towns, Nature offers a remedy for some of the evils alluded to: our country possesses its mountain ranges on the one hand, and wide-spreading tracts of water-bearing formations on the other, and there are few towns of importance, at least in the Central and Northen Counties, which are inaccessible to one or other of these sources of water-supply. In the one case, the mountains receive the rainfall on a surface nearly free from hurtful impurities, and thence it is formed into brooks and lakes; in the other, the rocks gather and imbibe a portion of the rains, and retain it until raised again to the surface by mechanical appliances.

Of the several water-bearing formations of England, the Chalk and the New Red Sandstone are by far the most important, the former occupying parts of the South and East of the country; the latter parts of the Midland and Northern Counties; with this we are only here concerned, except that we may remark that of the two formations the Chalk occupies by much the largest area; while from its situation it receives proportionately less rain on its surface than the New Red Sandstone, so that the actual quantities imbibed by each, *ceteris paribus*, may not be very different. In each case the formation is homogeneous; is of considerable thickness; occupies large areas of country, and is easily permeable to water. These are the essential qualities of all water-bearing formations of any pretensions.

Confining our attention to the New Red Sandstone (or lowest division of the Trias), we shall notice in order the above characteristics upon which its capacity for retaining and yielding large quantities of water depends.

And first as regards its homogeneity, or uniformity of mineral composition (we use the term merely as it applies to our present inquiry), there are doubtless different members, some slightly harder and less porous than others, but the whole formation is essentially a sandstone or conglomerate, rarely containing bands of clay or shale, and hence, whatever water falls on its surface, finds no barrier to its vertical descent beyond the density of the rock itself. What is true of the rock as regards the facility of vertical percolation is true also of lateral, so that in general the formation may be considered permeable in every direction. The late Mr. R. Stephenson, whose views on this question time and experience have only served to confirm, in his Report on the Supply of Water to Liverpool, says, "My opinion is, that on considering the question of the supply of water, the rock (New Red Sandstone) may be looked upon as almost equally permeable in every direction, and the whole mass regarded as a reservoir up to a certain level, from which whenever wells are sunk water will always be obtained more or less abundantly." Such qualities are obviously of the highest importance, because they enable a well of sufficient depth *to draw* from long distances around, and thus to yield a large supply. Thus the Green Lane Well, east of Liverpool, which by sinking and boring reaches a total depth of 385 feet, and yields upwards of three millions of gallons per day, is stated by Mr. Duncan, the resident engineer, to have influenced wells several miles distant.

In the Midland Counties the formation consists either of a soft variegated sandstone, or of a quartzose conglomerate, both nearly equally porous, and available as sources of water-supply; and of these large areas occur in the neighbourhood of Birmingham, Stafford, Wolverhampton, Kidderminster, Derby, and Nottingham.

The second important feature of the New Red Sandstone is its great vertical thickness, especially in the counties of Cheshire, Lancashire, and Salop, where it is over 1,000 feet. In the Central Counties the thickness is less, and in the eastern parts of Leicestershire and Warwickshire the rock thins out altogether. This thinning away of the formation takes place from North-west to South-east, and may be thus expressed:—

	Thickness in Feet.
Lancashire and Cheshire	1,200 to 1,000
Derbyshire, Staffordshire, Nottinghamshire .	600 to 150
Warwickshire and Leicestershire . . .	150 to 0

Hence it will be observed that there are parts of the country where these water-bearing beds do not exist, and this is the case under Rugby.

With such a vertical development in the Central and North-western Counties, we may conclude there is a somewhat proportionately large horizontal area exposed to the rain-fall; but another consequence is the vast extent of storage-room thus afforded by this formation; both are necessary for the capability of yielding large quantities of water, for a thin stratum, however widely spread out, could never yield very large supplies. Now the area occupied by the New Red Sandstone in the Counties above named is over 1,000 square miles, and with an average rainfall of 30 inches, we may assume that every four or five square miles will be capable of yielding one million of gallons daily.* Taking the latter figure, we have a total supply of 200 millions of gallons capable of supplying at the rate of 20 gallons per head ten millions of people, or half the population of England and Wales. Such a calculation may doubtless be considered rough, and may require considerable modification on various accounts; but it will serve to show, after making every deduction, that we have, placed within reach, sources of supply which, if not inexhaustible, will certainly prove sufficient for the wants of many generations; for it is probable that at present not more than fifty millions of gallons are raised from the New Red Sandstone.

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* This rate of yield has been determined pretty well by several observations in Lancashire and Cheshire.

Some idea of the enormous supply which this formation is capable of yielding from wells advantageously situated, may be gathered from returns of some of the wells now in operation. Amongst the more remarkable is the Green Lane Well, which is situated about two miles east of Liverpool. The details of the works which have been carried on, as kindly furnished to the author by Mr. Duncan, will not be without interest, as they illustrate the connection which exists between increase of supply and increase of depth and diameter of the well, or boring, as the case may be.

The well was sunk in 1845-6, the surface being 144 feet above the sea-level, and the depth of the well 185 feet; or 41 below the sea-level.

At first the yield was 1,250,000 gallons per day. A bore-hole, 6 inches in diameter, was then driven to a depth of 60 feet from the bottom of the well, when the yield increased to 2,317,000 gallons. In June, 1853, the supply had slightly fallen off, being 2,303,000 gallons, upon which the boring was still further carried down 38½ feet, when the yield increased to 2,689,000 gallons. In June, 1856, the bore-hole was widened, and carried down 101½ feet farther, when the yield amounted to its present supply of 3,321,000 gallons per day. Now, in these boring operations, we arrive at the following results. In the first boring of 60 feet, the increase was at the rate of 17,783 gallons per foot; in the second, of 38½, the increase was only at the rate of 9,789 gallons per foot; and in the third only 6,277 gallons per foot. It is easy to perceive that any further increase would be at a rapidly diminishing ratio with the depth, until a zero point had been attained.

In 1850, the average supply from seven public wells in Liverpool was 4,216,784 gallons every twenty-four hours.* It is now probably upwards of 5,000,000 gallons drawn from an area of about twenty square miles. The wells of Manchester and Salford, of which only that at Gorton is public property, yield about 6,000,000 gallons, exclusive of the well at the works of Messrs. Bailey and Craven, at Agecroft, near Pendleton, where from a well and bore-hole reaching a total depth of 435 feet, it is stated that no less than 5,000,000 gallons a day can be raised when the engines are in full operation.†

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* Mr. R. Stephenson's Report.

† The boring was executed with the machine of Messrs. Platt and Mather. For an account of the yield of this well I am indebted to Mr. S. C. Homersham, C.E., for whom the amount was ascertained in 1859.

Several wells have been successfully sunk near Birkenhead, one under the direction of Mr. J. Cunningham, for the Wirral Water Works Company, capable of yielding 2,000,000 gallons a day; others by Mr. F. Bateman, C.E., of which one at Flaybrick Hill, though still incomplete, yields 800,000 gallons.

At Nottingham, several wells for the supply of the town have recently been sunk under the direction of Mr. Hawksley, from which the supply is very large. The rock is there in the form of a slightly consolidated conglomerate, and hence extremely porous. One of the wells yields 3,000,000 gallons per day, another 2,880,000 gallons, and the supply from a third cannot be tested, owing to the fact that the inflow of the water is too great for the engines to make head against.

At Birmingham, out of 7,000,000 gallons supplied by the Company, 2,000,000 are derived from wells which will be very largely augmented on the completion of the works now contemplated, and which include the sinking of four new wells. There are also several large private wells in operation. These instances will probably be considered sufficient as regards wells; my last illustration will be that of a natural spring rising from the same formation.

The town of Leek, in Staffordshire, stands on a tongue of New Red conglomerate, lying in a valley bounded by hills of millstone grit. A short distance to the south of the town, the Wall Grange springs burst forth at the foot of a knowl of New Red Sandstone, from which all the Pottery towns, except Longton, Fenton, and Stoke, are supplied. The position of the well is shown in Fig. 1.

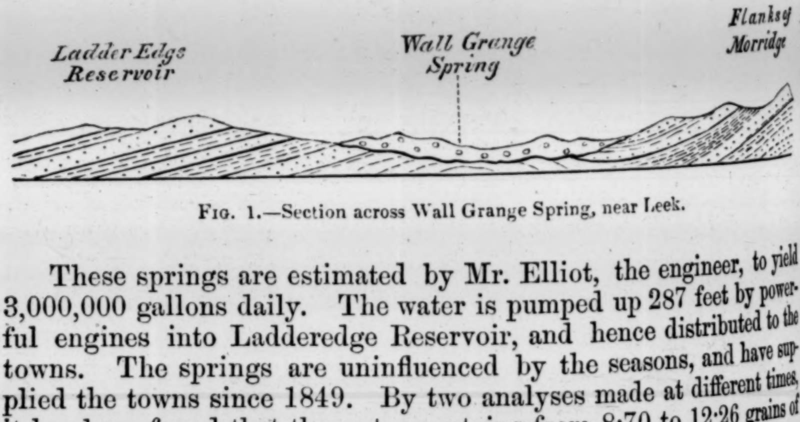

FIG. 1.—Section across Wall Grange Spring, near Leek.

These springs are estimated by Mr. Elliot, the engineer, to yield 3,000,000 gallons daily. The water is pumped up 287 feet by powerful engines into Ladderedge Reservoir, and hence distributed to the towns. The springs are uninfluenced by the seasons, and have supplied the towns since 1849. By two analyses made at different times, it has been found that the water contains from 8·70 to 12·26 grains of foreign matter per gallon.*

The porosity of the New Red Sandstone—owing to which water is able to percolate from long distances, is illustrated by the preceding examples. As only a small proportion of the rain which falls on its surface, varying from one-third to one-fourth, finds its way into the rock, it is evident that in order for a single well or spring to yield 3,000,000 of gallons a day, the supply must be drawn from considerable areas around. The porous character of the rock also finds another curious illustration in the case of some of the Liverpool wells. Out of four large wells in the lower part of the town, three have become charged with brine from the sea, owing to the extraction of the fresh water, and the general lowering of the water-level in the rock. The most remarkable case is that of Mr. M'Gregor's Well, situated at a distance of 1,200 yards from the shore, which now yields salt water. The cause of this is not difficult of discovery. Before pumping operations were commenced at Liverpool, the water-level in the rock was the same as that of the sea close to the shore, but inland gradually rose with the surface of the ground. Thus, when the Green Lane Well was first sunk, the water-level was found to be only 38 feet from the surface, or 106 feet above the sea. The sinking of many wells, and the extraction of the water from the rock, necessarily tend to lower the water-level, and near the sea to bring it below the sea-level. The balance of the water in the rock, and that of the sea being thus destroyed, the sea-water forces a passage for itself inwards. The water-level at Green Lane is now 70 feet from the surface, that is, 32 feet lower than when the well was first sunk.

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* 'Geology of Leek.' By T. Wardle, F.G.S.

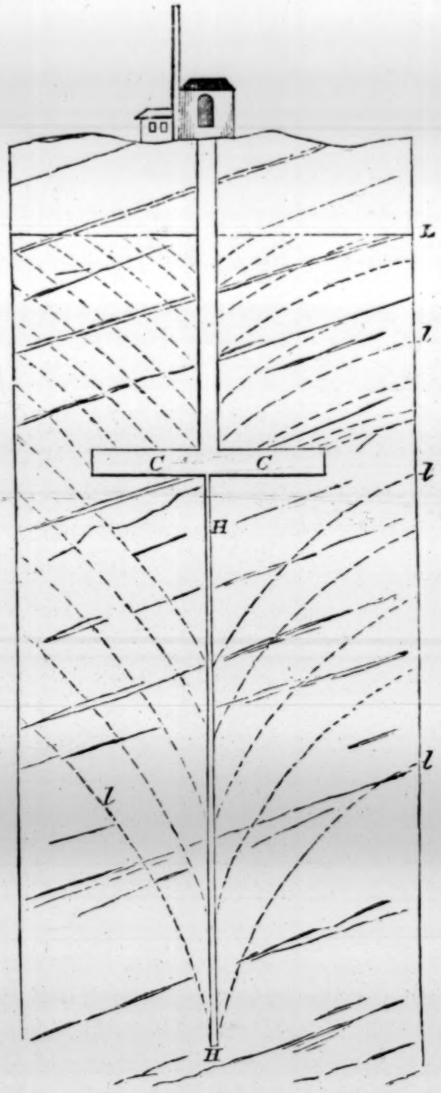

FIG. 2.—General Section of a Well, with Chambers and Bore-hole.

Notwithstanding the porous character of the rock, the process of percolation is extremely slow, and on this account the sinking of a well has little or no effect on the vegetation, and sometimes a shallow well is not perceptibly affected by the neighbourhood of a deep one. But a more remarkable result still remains. It has been found that the yield is greater in the summer—that is, in the six dry months—than in winter—the six wet ones. Mr. Hawksley, whose experience in these matters is undoubtedly large, stated in evidence before a Parliamentary Committee during the present Session, that of the total quantity of water drawn from deep wells in certain situations, 2-5ths are supplied during the six winter months, while 3-5ths are supplied during the remaining six months of the year, so that six months is required for percolation. The same fact has been stated to the writer in the case of a well in South Lancashire, and it is owing to this remarkable property of admitting of slow percolation that the rock becomes in effect both a natural filter and a reservoir. During the slow percolation of the surface-water—noxious impurities are separated from the pure element, and a store is also laid up in seasons of plenty to be dealt out in times of dearth. On the other hand, water derived from surface drainage, in order to be made permanently useful, requires the construction of "lodges" or basins for the storage of the surplus waters of wet seasons.

It may here be proper to describe shortly the process of filtration as well as the general manner of constructing a deep well in this New Red Sandstone. (See Fig. 2.)

The site having been chosen, a well of a diameter sufficient for the play of a double-pumping engine, is commenced and carried down till the natural water-level (*L*) is reached. A temporary (or permanent) engine is then put up, and the water is kept down, until it threatens to become too plenteous for the engines to deal with. Large chambers or tunnels (*C C*) are then generally driven in opposite directions for lodgment, and from the floor, a bore-hole (*H*), of 6 to 12 inches in diameter, is driven to any required depth. Now the manner in which the water is drawn from the surrounding sandstone rock is somewhat as follows. Before the well is sunk, and supposing the rock to be homogeneous (which is, of course, not strictly the case), the water will be found standing at a certain level depending on the position of the springs and other natural or artificial sluices. This water-level (*L*) is only approximately horizontal, as it tends to vary with the surface, and rises and falls according to the season. The water, however, is at rest, or *in equilibrio.* But when a well is sunk below this level, and this water is extracted, the equilibrium is disturbed. A vacuum is created into which the surrounding waters will flow, in order to fill it up. Two forces will then be brought into play—gravity and lateral pressure acting vertically and horizontally—both of which are resisted by the friction of the rock—which will be proportional to its density—and the resulting motion will be a diagonal series of curved lines (*l, l, l,*) converging towards the axis of the well. From the above description it will be apparent that in order to increase the area of supply, it is necessary to deepen the well—and that the limit to the distance will be reached when the friction of the rock is equal to the lateral pressure.

The above general principles are subject to modification, arising from the unequal density of different beds, the stratification of the rock itself, bands of marl faults and fissures. As the effect of these latter is not unfrequently a matter of controversy, I shall say a few words on the subject here.

Faults (or vertical dislocations) in the New Red Sandstone differ from those in the Coal-measures in being filled in with broken silicious material (often indeed ground and hardened, but full of fractures), instead of clay or other impervious matter, which in the working of a coal mine often renders the presence of one of these faults a barrier to the passage of water, and a very great blessing to the miners. Faults in the New Red Sandstone, hundreds of which the writer has examined over the Central Counties, cannot therefore be regarded as impervious to water, because the material with which they are filled in is not itself impervious. It is not improbable, however, that they tend to retard the flow of the water in a transverse direction; but on the other hand, they act as channels, and ducts, to guide it longitudinally. Hence the writer would (*ceteris paribus*) always recommend the line of a fault as the best site for a well, as it is certain to draw from a long distance. The effect of a fault in suddenly increasing the supply when driven into underground was illustrated in the case of the well at Flaybrick Hill, near Birkenhead. Mr. Bateman, the engineer, recently stated* that in driving a tunnel from the bottom of the well, they struck upon a fault of several feet in width, when the supply, which had only been 400,000 gallons per day, was suddenly doubled. What will be the effect of cutting through one or more of such faults in tunnelling under the bed of the Mersey, is a matter which is exciting much controversy between the promoters and opponents of the Railway Tunnel scheme; but that the former contemplate in any case a very large influx of water from the bed of the river may be concluded from the fact that they are preparing pumping powers for twelve millions of gallons per day. The project, however, is now in abeyance.

Quality of the Water.—We now come to the last and not least important question, the quality of the water from the New Red Sandstone, as ascertained by experience. It is but fair to say that on this point much variety of opinion exists, as there are different views as to what constitutes "hard" and "soft" water, and as the water itself is somewhat variable. That it is pleasant, and sparkling, and good for drinking, none will be disposed to deny; and, as regards hardness, it is certainly not as soft as the water from Lough Katrine, while it is softer than that generally drawn from wells in the Chalk formation.

In Manchester, Stockport, and other places in the North of England, the waters from wells in the New Red Sandstone and Permian formations are extensively employed in brewing, bleaching, and dyeing; and though salts of iron, lime, and magnesia exist in almost all cases, we are only aware of one solitary instance where the water proved unfit for use by the excess of any of these salts.† The case alluded to occurred at Ordsall, near Manchester, and is, we think, the result of exceptional causes capable of explanation. On the other hand, a well in the same formation at Parkside, on the London and North-Western Railway, produces water of such purity, that Mr. Ramsbottom declared to the writer that it was the purest water for the supply of locomotive engines on the whole of the railway system.

The terms "hard" and "soft" are often used in a sense that is vague and unsatisfactory, but adopting the views of Dr. Clark, that it is the presence or absence of salts of lime and magnesia that constitutes hardness or softness, while those of potash or soda are neutral, we have an intelligible basis of comparison. According to this view, which is very generally adopted, we may express the degree of hardness in a sample of water according to the number of grains of salts of lime and magnesia per gallon it contains. The standard of purity is water obtained by repeated distillation, but for ordinary purposes absolutely pure water is unfit for use, the presence of mineral matter being essential to the animal economy. Water which contains mineral matter in small quantities is the best adapted for use, and such, we think, it can be shown is the character of that derived from wells in the New Red Sandstone.

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* Before the Parliamentary Referees on the Mersey Tunnel Bill, 1865.

† It need hardly be mentioned that our remarks exclude all notice of the water derived from the *New Red Marl*, the upper division of the Trias from which the principal supply of salt and brine is derived.

We proceed to give the results of analyses of samples derived from wells in different parts of the country, commencing with Liverpool, which will serve to give reliable information regarding the quality of the water. Several of these analyses have been kindly supplied for this paper.

Analyses of Water from Wells in New Red Sandstone.

LIVERPOOL DISTRICT.

The following analyses were made by Mr. Richard Phillips, for the Liverpool Corporation:—

	BOOTLE. Grs. per gal.	SOHO. Grs. per gal.	WINDSOR. Grs. per gal.	GREEN LANE. Grs. per gal.
Sulphate of Lime .	3·31	5·44	0·49	0·00
Carbonate of Lime .	7·10	2·94	8·70	5·26
Carbonate of Magnesia .	6·93	8·81	7·43	2·66
Chloride of Sodium .	3·37	4·47	3·42	2·23
Silica	0·48	1·12	1·20	0·63
Organic matter Potassium and loss .	2·81	2·02	1·94	2·81
	24·00	24·80	23·22	13·60

MANCHESTER DISTRICT.

As a general result the waters from the Manchester wells contain 14 grains of salts of lime in a gallon, *viz.* 8 grains of sulphate and 6 grains of carbonate. For the following special example, taken from the south side of Manchester, the author is indebted to Dr. R. Angus Smith, F.R.S.:—

	Grs. per gal.
Chloride of Sodium	4·88
Sulphate of Soda	7·33
Carbonate of Soda	7·35
Carbonate of Lime	9·77
Carbonate of Magnesia	5·29
Phosphoric Acid, Lithia, Potash . . .	traces
	34·62

Degrees of hardness . . 15·0

The Lithia was seen by the Spectroscope.

Analysis of Water from a Well at Parkside, near Warrington, belonging to the London and North-Western Railway, by Mr. Dougall Campbell, F.C.S., of London. Total solid contents per gallon 11·12 grains, consisting of:—

	Grs. per gal.
Silica	0·80
Oxide of Iron	0·24
Carbonate of Lime	1·07
Sulphate of Lime	1·63
Sulphate of Magnesia	1·46
Carbonate of Magnesia	0·70
Chloride of Magnesium	0·71
Chloride of Sodium	1·76
Volatilized Matter	2·64
Potassium and loss	0·11
	11·12

Degree of hardness before boiling . 5·8
" " after boiling . . 4·1

Analysis of water from a well belonging to the Waterworks Company at Aston, near Birmingham, by Dr. Hill, F.C.S., Analyst to the Borough of Birmingham:—

	Grs. per gal.
Carbonate of Lime	4·40
Carbonate of Magnesia	2·70
Carbonate of Soda	1·62
Chloride of Sodium	1·08
Sulphate of Soda	0·70
Silica, Iron, Alumina	0·62
Organic matter	1·70
	12·82

Degree of hardness before boiling . 5·9
" " after boiling . . 1·5

Dr. Hill has assured the writer that the above may be considered an average sample of the water around Birmingham, as it is similar to a specimen from the well of the borough prison, which lies at an opposite quarter of the town.

Wall Grange Spring, near Leek, Staffordshire. Analysis by Mr. Phillips, in 1847:—

	Grs per gal.
Chloride of Sodium (common salt)	1·33
Sulphate of Lime	5·79
Carbonate of Lime	4·73
Traces of Magnesia, Silica, Organic Matter, and loss by operating	0·41
	12·26

Degree of hardness . . . . 10·5

The following analysis of the water from the well of the Stourbridge Water Company has been kindly supplied by the resident engineer, Mr. E. Bindon Marten. The well is only 46 feet deep, and yields about 200,000 gallons per day.

WELL AT STOURBRIDGE, WORCESTERSHIRE.

	Grs. per gal.
Carbonate of Lime	15·23
Sulphate of Lime	0.47
Sulphate of Magnesia	1.67
Chloride of Sodium and Alkalies	1·76
Organic matter	2·07
Loss	0·77
	21·95
Degree of hardness	17·2

We regret that we cannot furnish a special example from the wells at Nottingham. We are only able to state that the analysis of one of the principal wells gives of salts of lime and magnesia 11·8 grains, other salts 4·2 grains, and of volatile and combustible matter 0·88 grains; making in all about 16·80 grains per gallon. The foregoing examples will, however, probably be considered sufficient to establish the character of the water from the New Red Sandstone.

In order, however, fully to understand the position which the water from that source holds in the scale of purity, we must compare it with that at present supplied to various towns from other sources. From the above cases it will be observed that the quantity of ingredients varies from 6 to 34 grains per gallon. Let us see how this bears comparison with other waters.

Amongst the towns which are supplied with the purest water are Glasgow, Manchester, and Aberdeen, from Lough Katrine, the Yorkshire Hills, and the River Dee respectively. In these cases the water is supplied by the surface drainage of hilly districts formed of ancient Palæozoic formations, and the ingredients vary from 2·95 to 4·00 grains per gallon. Such waters are undoubtedly purer than any that can be drawn from wells, but they are more liable to be charged with peaty matter, especially after rains.

Amongst those in the next scale may be placed Newcastle and Paris, supplied from the Tyne and the Seine respectively, which contain from 11 to 12 grains per gallon.

Amongst those in the third class, the various districts of the Metropolis may be placed, and these labour under the serious disadvantage of being charged with organic impurities in proportions varying from 1·40 to 3·68 grains per gallon. The purest of these waters seems to be that of the New River Company, which contains 17·20 grains, and the least pure that of the Kent Company, which contains no less than 29·84 grains of ingredients to the gallon, of which 3·68 grains are organic matter.

Having regard then to the instances here cited, we think we can have no difficulty in assigning to the waters from the New Red Sandstone an intermediate position, with this great advantage, that nearly all the foreign ingredients must be mineral and not organic.* In truth, the rock is a wonderful natural filter. Receiving as it does on its surface water from various sources, and charged with impurities of various kinds, it imbibes a portion, allows it to percolate downwards in a slow and gradual descent, every instant extracting some noxious particle, till the liquid is freed from every substance injurious to human life, and is returned to us limpid as the waters of a brook which gurgles along the rugged bed of a Highland glen.

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* The sample given above, from Manchester, containing 34 grains of various salts, is evidently somewhat exceptional, and may possibly be affected by buildings and factories.

THE DEPREDATIONS OF INSECTS AND THE PROTECTIVE VALUE OF SMALL BIRDS.

By Prof. James Buckman, F.L.S., F.G.S., &c.

The readers of this Journal are well aware that a doltish antipathy to small birds has for a long time prompted a crusade against those useful little creatures, and with a view to expose the senseless nature of these proceedings as well as to give to the uninitiated reader some insight into the character of the plague which is thereby enabled to spread unopposed, I propose in the following brief observations, to treat of one particular insect enemy, whose devastations have recently forced themselves in an unpleasant manner upon my notice; I mean that commonly known as the Striped Pea Weevil.

Both in my garden and in the field I have of late lost crops of peas, and in some cases the loss has been rendered more mortifying, inasmuch as I had selected choice seeds and devoted great care to the cultivation of early plants. In the case of the garden crop, my gardener had unhesitatingly attributed the destruction to "sparrers," whilst the cause assigned for the ruined appearance of the plant in the field was "slugs." The real cause was, however, the little insect which I am about to describe, and which, on the occasion to be referred to, I found flying about in such numbers, that they became entangled in my whiskers, and thus gave unmistakable evidence of the wholesale destruction which they must inevitably cause.

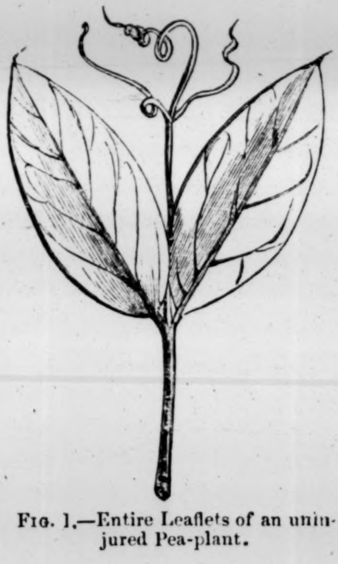
Fig. 1.—Entire Leaflets of an uninjured Pea-plant.

If we look at the leaf of the young pea we shall find it to consist of two *entire* leaflets, that is, without divisions at the margin—"*leaf bifoliate, leaflets entire;*" and which is terminated by a tendril which represents other leaflets diverted to the purposes of climbing.

Now in the injured leaves we have the appearance of pieces having been bitten out around the margin: this is either unobserved, or if noticed, it is thought by some to be the nature of the leaf, while of those who recognize it as abnormal not a few, as it seems, put it down to the pecking of birds, or the bites of slugs. The following woodcut will explain the nature of the injuries we are describing.

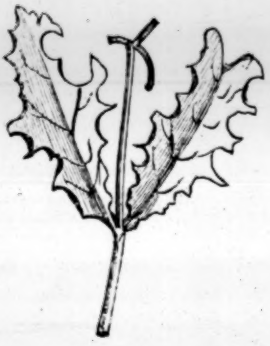

Fig. 2.—Pea Leaves eaten by the Pea-weevil.

Our Fig. 2 represents a much eaten leaf, but in some the parts are so evenly eroded as to cause them at first sight to appear to be the natural toothing of the leaf. A little reflection will, however, show us that we have no examples of leaves so *escalloped* (not to be confounded with *crenations*, which consist of a series of outward and not inward marginal curves). In some instances the whole leaf is destroyed, until indeed the plant ceases to live, as it has been the case with my garden crops; and this year my field crop has suffered a loss of about one half. I counted as many as 25 insects to a foot of the row, or 1650 to every chain in length, and Curtis asserts that "in the year 1844, they were universally distributed and ate off the *second and third sowing;*" and he further adds, that "some very naturally accused the sparrows; traps were set for rats and mice; lime strewed for slugs and snails; and toads were encouraged to extirpate wood-lice; but still the crops kept disappearing, as none of these precautions affected the wary enemy in his coat of mail."

It is now time to describe the nature of so mischievous a creature, which belongs to the order *Coleoptera*, family Curculionidæ, genus Sitonia (Curculio). Of this there are two species which attack our peas, beans, clovers, and other Papilionaceæ, *namely*:—

Sitonia lineata (Linn.), the Striped Pea Weevil.
Sitonia crinita (Olivier), the Spotted Pea Weevil.

These vary in size from two to three lines, the latter being somewhat less than the former; they are both brownish externally, much of the colour of the soil. The S. crinita appears darker and sometimes almost black when the greyish scales are worn off the Elytra,—otherwise they are much alike, and behave so similarly, that a description of S. lineata may serve for both.

It is of an earthy colour; is more or less elongated into an elliptical or oval shape. They may be seen sometimes in threes and fours on the edges of the leaves making the notches, as shown in the woodcut, and when these are present in the crop, the creatures will soon be detected in the act of feeding, if cautiously approached; if not, they fall off and disappear beneath the clods of earth, where they feign death, until all sign of danger has passed away.

Where the creatures are bred is at present a mystery, but I suspect that this operation takes place on wild Papilionaceæ, from which they migrate to their more pleasant food of peas, and it would appear that the more delicate of these are the favoured food of this mischievous creature.

In my own crop, not having enough of the early Warwick—a fine white pea—the headland was drilled with a grey pea, the nine pod;

the former were nearly destroyed, while the latter as nearly escaped altogether. So in an adjoining field belonging to a neighbour, there is now a fine crop of grey peas almost untouched. Curtis, in his 'Farm Insects,' says, "From the imperfect and slender data relating to insects connected with agriculture, it is frequently difficult, if not impossible, to form any opinion as to the simultaneous or periodical appearance of the different species; and with regard to these Weevils, all that can be stated is, that certain seasons seem to favour their multiplication, and others to check it. It is evident that if not checked, there is not a crop, whether in the field or garden, that would escape destruction; and this check, probably in every instance, might be traced to the agency of other insects, especially parasitic species, which I have so often shown are destined to the service of man."*

But now the question arises whether the parasites referred to by Curtis have not some good assistants in this goodly work of destroying noxious insects.

Now it happens that about my farm there are, amongst other birds, hundreds of larks, *Alauda vulgaris*, and white water wagtails, *Motacilla alba*. My pupil, A. Taylor, Esq., has occasionally shot specimens of these and other species, and has examined them in order to determine their food; in the crop of a lark from this very field were several of these weevils, and in the gizzard a complete débris of small insects. In the wagtail, from the same field, the crop was full of weevils, and in the gizzard, a mass of elytra of these and other small beetles.

A reed-warbler (*Silvia arundinacea*) again from the farm, had in the gizzard twenty-five beetles of different species.

This then seems to be the tendency for good of some small birds; so much so indeed that if they were allowed fair play, I believe that this periodical superabundance of insects from which our crops frequently suffer would be rendered next to impossible.

As a curious illustration of what even seed-eating birds do, I may direct attention to a hedge sparrow, *Fringilla montana*, shot in the pea-field. In its gizzard were found several hundreds of the seeds of the *Chenopodium album*, a weed which was very troublesome in a potato crop of the former season. All sparrows then are not mischievous, nor indeed any, at all times.

It seems then from the foregoing that crops are liable to a variety of insect attacks; as these injuries were supposed to result from birds, the birds have been destroyed as enemies, while a knowledge of the real truth should lead us to preserve them as friends.

In the case before us, were it not that a very much-used path skirted the pea crop, the injury I have described would, in all probability, have been kept under by the birds, a fact which in this and in other instances has led me to attempt plans to prevent their molestation, rather than to adopt that everlasting opposition to them which has been productive of so much mischief.

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* P. 347.

CHRONICLES OF SCIENCE.

I. AGRICULTURE.

In the current number of the 'Transactions of the Highland and Agricultural Society,' Professor Thomas Anderson has described his experiments on the action of uric acid as a manure. They are of considerable importance as illustrating the fertilizing action of guano. Of this, indeed, agriculturists need no other proof than that which their own experience offers; but for harmonizing this experience with the theory of manures, any attempt must do valuable service which shall ascertain the influence upon the growth of plants exercised by those other nitrogenous ingredients of guano, which are present in addition to its ammonia. It is because Liebig had declared that in discussing the value of Peruvian guano as a manure the nitrogen present in its uric acid should not be taken into account, that Dr. Anderson has made it the subject of his present research.

Peruvian guano, guano ash, uric acid, and sulphate of ammonia, were the materials employed in his experiments. The first formed the standard, and it was contrasted first with a mixture of its own ash with uric acid in such proportion as to contain exactly the same quantity of nitrogen as the guano itself did, and next with a similar mixture of the ash with sulphate of ammonia. The crops (turnips and wheat) thus received in every case exactly the same quantities of mineral matters and of nitrogen, but the latter element existed in one case entirely as uric acid, in another entirely as sulphate of ammonia, and in the guano itself partly as ammonia and partly as uric acid. The results on the turnip crop were obtained from a late sown crop, and are so far not altogether satisfactory; they proved in every case the mixture of guano, ash, and sulphate of ammonia to be best; then the guano itself; and lastly, the guano ash, and uric acid. The conclusion here, therefore, was favourable to the ready formed ammonia as a source of nitrogen. It is not, however, upon the turnip crop, but upon the grain crop, that the true effect and influence of nitrogenous manures is to be read. And on the wheat crop it appeared that the guano ash by itself was entirely without effect; the produce, where it alone was used, being no better than where nothing at all had been applied. In every case, however, the nitrogenous manure produced a very marked increase in the crop, and but little difference was observable in the action of the guano, the uric acid, and the sulphate of ammonia. In one set of experiments the guano was best, the sulphate of ammonia next, and the uric acid third. In another series, the uric acid was first, the sulphate of ammonia second, and the guano third. Taking the average of the two series, the produce per acre of equal quantities of nitrogen in the manure, in the form of uric acid, was 50·9 bushels per acre; in the form of guano, it was 49·8 bushels per acre; and in the form of ammonia, 50·4 bushels per acre. Where nothing had been used as manure, the produce was 40·9 bushels per acre; and where guano ash alone was used, the produce was 40·1 bushels per acre. As Dr. Anderson states, although these experiments will be the better for confirmation, yet in the meantime they establish beyond all doubt that uric acid is capable of promoting the growth of plants and that, as a source of nitrogen, it is on the whole equal to sulphate of ammonia or guano.

Mr. Lawes has subjected to an experimental test the suggestion of Professor Voelcker, that in order to increase the efficiency of Peruvian guano as a manure for root crop, it would be well to moisten it with sulphuric acid, this being best effected by mixing it with sawdust, over which the sulphuric acid had been poured. It was supposed that the guano would be increased in efficiency, both by its volatile ammonia being thus fixed, and by its phosphate of lime being rendered soluble. The experiment performed in a dry season, which produced a very poor crop of roots, did not corroborate the suggestion: the crop from 8 tons of dung and 200 lbs. of Peruvian guano in its natural state being rather better than where the guano added to the dung had been previously treated as was suggested. On the other hand, when to both of these dressings 2 cwt. of superphosphate of lime had been added, there was a corresponding small advantage the other way. The results on the whole, therefore, are nugatory; and as the cost of the acid and expense of mixing were thus spent for nothing, the experiment, so far as it goes, discourages the practice which had been recommended. Several sets of experiments have been lately published on the value of ground coprolites, as a manure for the turnip crop. Mr. Baldwin, of Glasnevin, Dublin, Mr. Kensington, F.C.S., and others, have observed a marked increase of produce from their use, which contradicts the general impression of their worthlessness in an undissolved state. The experiments need, however, repetition.

Dr. Voelcker has called the attention of the English Agricultural Society to a source of potash as a manure which has recently become available. A great thickness of potash, bearing earthen beds, is traversed in the Strassfurth Salt Mines, before the enormous deposit of pure rock salt is reached which there exists. Various extracted potash salts are obtained from these preliminary beds, some of them deliquescent muriates, and one, a sulphate, selling at about 3*l.* a ton, and containing 20 per cent., which is likely to be imported into this country for agricultural purposes. Dr. Voelcker recommends experiments with these crude potash salts upon light soils for turnips, potatoes, and clover: (1) alone, at the rate of 3 cwt. per acre; (2) alone, in comparison with an equal quantity of common salt; (3) mixed with an equal quantity of superphosphate of lime; and (4) mixed with 3 cwt. each of both common salt and superphosphate. The bean crop has been benefited in farm practice by the application of wood ashes as a manure, and these potash salts may thus also be applied to beans with some prospect of success.

Baron Liebig has published a letter upon the progress of the artificial manure manufacture in the Grand Duchy of Hesse, declaring that since Dr. Schneider commenced in that district, ten years ago, as the agent of the Rhenish Agricultural Society, to lecture on the principles of the so-called "Mineral theory," fifty-seven depôts of artificial manure have been established within an area of twenty-five geographical (German) square miles, or nearly 340,000 acres. During 1863, 90,000 tons of artificial manure, more than 5 cwt. per acre over the whole of this area, were used; and in consequence of this habitual use of imported fertilizers, rents have risen 20*s.* per acre, corresponding to an increased capital value of 10,000,000*l.* over the whole district, or 30*l.* per acre. This Liebig considers "a proof that the state of agriculture in land is really improving." And holding firmly to his previous declaration, that owing to our waste of sewage, the fertility of Great Britain is undergoing an exhaustion, he contrasts it with our average use of guano and other imported fertilizers which he puts at 400,000 tons per annum, or something less than 28 lbs. per acre. "This simple fact shows," he says, "how very small, comparatively, is the augmentation of the conditions of fertility in the English soil by the importation of manure. On the other hand, the loss of manure suffered by agriculture through the waste of the sewage is notorious, and may be found far exceeding the amount made good by importation; and then the inevitable conclusion remains, that as a whole the soil of England, instead of gaining, must actually decline in productive power." It is impossible to avoid the conclusion to which Liebig's previous writings lead, that there is a strong prejudice which warps his mind in the case of any comparison of Germany and England. His great proof of agricultural progress in Hesse is none other than that dependence on supplies of fertilizing matter from without, which has been more than once condemned by him, when alleged by Englishmen as some explanation or palliation of their folly in the neglect of their home supplies with which his letters on the sewage question charge them.

A little book on 'High Farming without Manure,'* has lately been published, being an English translation of six lectures on Agriculture delivered by M. George Ville, at the experimental farm at Vincennes. But the title, which would indicate a much easier solution of our agricultural difficulties than either Liebig or his Hessian model farmers could afford us, is not a correct designation of its contents. M. Ville first recommends a thorough fertilization of the soil, and thereafter the application, before every crop, of the special fertilizer which he supposes it to need. This is *nitrogen* for cereals, *potash* for beans and pease, and *phosphates* for roots. This, however, is no new doctrine here. The English farmer has all along tried to keep his land in good heart by an economical use of home resources, and to these he adds guanos and nitrates for his grain-crops, and bone-dust and phosphates for his root-crops. And so far from M. Ville teaching "High farming without manure," his lectures are specially directed to the maintenance of the general fertility of the soil by the application of a compound and complete fertilizer; and afterwards to the maintenance of its fertility as regards every separate crop by the application of the special or dominant ingredient of the complete manure in which that crop makes the largest and most severe demands. It is not, however, so much by this latter particular treatment, as by the former general treatment that English farmers aim at the maintenance of fertility. It is an agricultural, not a purely chemical question, of which their practice is the true exponent. And the principal and leading explanation of an increasing fertility whenever over any considerable district in the country it is witnessed, exists in the maintenance of an increased head of stock upon a given area. Fortunately for English farming and for English soils, the relative state of the meat and corn market has of late more especially urged this as his interest upon the English farmer; and the purchase of sheep and cattle foods—both cakes, the refuse of the oil manufacture from various oil-bearing seeds, and grain and meals of various kinds, which have been unusually cheap—has become the best security for farm profits, whether they are dependent upon the quantity of meat made upon and sold from the farm, or on the quantity of corn grown there, owing to the increased quantity and quality of the manure thus made.

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* W. Olliver, 3, Amen Corner, Paternoster Row.

The value of covered yards for stock has been the subject of discussion during the past quarter before the London Farmers' Club and in the pages of the 'Agricultural Society's Journal.' Shelter for feeding cattle is useful, both as economizing the use of food in the processes of nutrition, and as preserving the soluble and fertilizing ingredients in the manure made during the feeding process. To this, ample testimony exists in agricultural experience, and has been lately borne by our leading agricultural authorities. The related subject of cattle food has also been of late discussed: Mr. Lawes' experiments on the nutriment in raw and malted barley respectively, have established the fact which might have been anticipated, on theoretical grounds, that the process of malting, by its destruction and dissipation of much of the actual material of the grain malted, diminishes the feeding powers of a given quantity of barley. The general result of Mr. Lawes' inquiry is, that in only one of the comparative experiments, *viz.* in the first and second lots of sheep experimented on, which were fed respectively, besides other things, on barley and on the malt produced from an equal quantity of that barley, was the increase of the weight higher, and the amount of food required to yield a given amount of increase lower, from the malt than from the barley; and in that instance the amounts were very nearly the same in the two cases. In all the other comparative trials, whether with oxen, sheep, or pigs, the advantage was with the barley, and in a greater degree than it had been with the malt in the single instance quoted.

An excellent and elaborate account of the existin gcattle foods, both home-grown and imported, was given by Professor J. Coleman, in a lecture before the Society of Arts, on April 5. Among other new substances named was the palm-nut kernel meal, which contains no less than 25 per cent. of a feeding oil, and 15 per cent. of flesh-forming material, and has proved on trial with cattle, sheep, and pigs, one of the most efficient and cheapest purchased foods we have. Its effect on dairy cattle in the production of milk is especially noteworthy.

Among the other topics which have been brought under the notice of agriculturists during the past few months by our agricultural societies are Flax-culture, Grass-land Management, Irrigation and the Water Supply, and Agricultural Education.

Flax-culture has received a large extension of late years both in this country and in Ireland, owing to the increased value of the fibre, which has been due to the diminished cotton supply. Mr. Beale Browne made it the subject of a recent lecture before the English Agricultural Society, in which he declared that it had lately proved more profitable than the wheat-crop, which it followed, even upon the poor thin Cotswold soils, where he had grown it. And in Ireland, where two successive crops may be had of the crop on freshly broken-up moory soil, which will grow nothing else until it has been limed, it is still more profitable. A rettery for extracting the fibre, where a market may be obtained for flax-straw, must be established, before flax-culture can be profitably introduced into any new locality; and there seems every reason to suppose that the crop may in this way, more generally than has hitherto been the case, obtain a place in the crop rotations of English farmers.

Grass-land management was discussed at some length at a meeting of the London Farmers' Club, being introduced by an exhaustive paper on the subject from Professor Coleman. Land-draining, and grazing with the use of auxiliary foods given both to cattle and sheep, are the great agents in the improvement of our pastures. The former has always been a profitable operation; and the latter is becoming more and more so with the rising price of meat in this country.

Irrigation, which is another great agency in the production of an increased grass-crop, was the subject of discussion by Professor Voelcker, before a recent meeting of the Agricultural Society of England. His lecture referred especially to the kinds of water suitable for use in this way. These were declared to be specially sewage water; next, those spring-waters which are of a uniform temperature throughout the year, both because they are thus warmer in the winter and spring months when an early growth of grass is thus promoted, and also because this uniformity of temperature indicates that such waters come from considerable depth; and having thus traversed a large extent of earth and rock, they are the more likely to have dissolved the various mineral matters met with, which are serviceable as the food of plants. Lastly, drainage waters are of service for irrigating the lower lands. And this is of importance, as checking that rapid flow of flood and rainwater from the field to the final outfall in the river, by which, as Mr. Baily Denton has often pointed out, the extension of land drainage is really affecting the water supply of the country; and, hurrying it straight away to the river, is tending more and more to make floods felt in all the low-lying lands. If by storage for irrigation purposes some use of such waters can be made before their final outflow into the river, a great social, as well as a mere agricultural, benefit will have been conferred.

Our last topic is agricultural education. The opening of the so-called Albert Middle Class College, in the county of Suffolk, during the past quarter, may be named under this head, as contributing both a good example for other counties, and directly to the work of general, and therefore indirectly to that of agricultural, education. It has however, been effectively shown by Mr. J. C. Morton, in a paper read by him before the Agricultural Society of England, that the general education of the farming class has during the past generation very greatly advanced; whereas the condition of their professional education is not so satisfactory. The sons are not better farmers, though they are better educated men, than their fathers were. Agricultural progress has been owing to improved means and improved machinery, to imported manures and cattle-foods, to land-drainage and better machines for cultivation—not to increased skill or greater agricultural knowledge. The object of the lecture was to induce the society to exert itself in its own legitimate field for the promotion of professional agricultural education — not to throw its small contribution to the subject into the great sea of general middle-class education, where it will not be felt. The Agricultural Society has, however, in the meantime, resolved to persevere in the experiment to which it is committed; and some 200*l.* accordingly have been devoted for the year in prizes to the sons of farmers who shall pass the best examination, before the university local examiners, in certain branches of a general education.

It is to be hoped that hereafter the society may labour in its own proper field as a professional agricultural body, offering prizes for agricultural proficiency, for knowledge of those branches of science in which agriculture is especially interested, and for intelligence and skill in the various departments of farm management.

II. ASTRONOMY.

(*Including the Proceedings of the Royal Astronomical Society.*)

One of the most interesting lectures delivered at the Royal Institution this season was devoted to a retrospect of the latest discoveries concerning the Sun's surface. The lecturer was Balfour Stewart, F.R.S., and although much of the matter brought forward has necessarily appeared from time to time in the pages of scientific journals, and especially in our own, we are tempted again to place it before our readers in a connected form, by giving a brief abstract of this valuable discourse. The speaker commenced by drawing attention to the points of visual difference between our two luminaries —the sun and the moon. The surface of the latter has been almost as correctly mapped as that of our own globe, so that astronomers have long known what parts of her were mountains, and what valleys; for it was comparatively easy to argue respecting a set of phenomena which do not differ greatly from those which belong to the surface of our earth. But the phenomena in our sun are so entirely different from any that we experience, and perhaps from any that we can conceive, that we must be exceedingly careful in our conclusions regarding them, that we may not be mistaken. We must throw away all speculation and hypothesis, and submit to be guided by observation alone. The luminous disc or surface of the sun is termed its photosphere, and inquiry with reference to this surface may be divided into three parts: the first, relating to the region above the photosphere; the second, to the photosphere itself; and the third, to the region below the photosphere.

To commence with the region above the photosphere, it is easy to show that it contains a very dense atmosphere which is of a comparatively low temperature. In the first place, according to a well-known law, the dark lines in the solar spectrum denote the presence of certain substances in the state of vapour, and yet in a comparatively cold state above the photosphere of the sun. These substances comprise, amongst others, sodium, magnesium, iron, and nickel.

Another proof of the existence of a solar atmosphere is that the light from the border is less intense than that from the centre of the disc; this is due to the fact that the light from the border has to pierce through a much greater depth of atmosphere than light from the centre, and hence a great portion of the light from the border will be absorbed by this atmosphere if it be colder than the source of light. The last proof of an atmosphere is that derived from the picture of the sun taken during a total eclipse. At the lecture some of Mr. De la Rue's celebrated eclipse photographs were projected on to the screen by means of the electric lantern, and the images of the corona and "red flames" were in this way exhibited to the audience. These photographs showed that as the moon proceeded over the sun's disc, the red flames and part of the corona discovered themselves at that side which she had left, and were covered up by her disc at that side towards which she was approaching; thus showing that they belonged to the sun.

Next, with regard to the photosphere, the first thing to be noticed is the fact that this is not a smooth, uniform, continuous surface. When it is viewed through powerful glasses, it appears granulated or mottled. But this is not all; there is reason to believe that great magnifying and defining power shows us something more, although it is very difficult to see it. Mr. James Nasmyth was the first to proclaim the curious fact that the whole photosphere of the sun is made up of detached bodies interlacing one another, and preserving a great amount of regularity both in form and size; he called them *willow leaves;* Mr. Stone has called them *rice grains*; Father Secchi *coups-de-pinceau.* It would be a speculation much beyond our power to conjecture what it is that gives these bodies their astonishing regularity of form. The lecturer then drew attention to the brighter portions of the photosphere, or faculæ, as they are sometimes called. It is chiefly near the edge of the sun that these relatively bright portions of the sun's disc appear, for when they come to the centre the difference in brightness between them and the surrounding parts of the disc is not so easily traced. Now the reason of their great brightness is believed to be that they are portions of the sun's photosphere thrown up into the higher regions of the atmosphere. This enables them to escape a great portion of the absorbing effect of this atmosphere, which, as before shown, is particularly strong near the border, and hence when there they appear much brighter than the surface around them; but near the centre the absorption is not great, so that they do not *gain much* by escaping it. The idea that these faculæ are elevations, has been confirmed by a stereoscopic impression of a sun spot and some faculæ taken by Mr. De la Rue, and in which while the spot appears to be a hollow the faculæ appear as elevated ridges. It thus appears that the faculæ are elevated, and further, that they retain the same appearance often for a considerable time, sometimes even for days together, so that faculæ are not composed of heavy matter, otherwise they could not remain elevated; and hence the faculæ, as well as the photosphere of which they are only the most elevated parts, are not composed of heavy matter, such as a molten sea, but are rather of the nature of a cloud.

The phenomena of the third region, or that below the photosphere, may be comprehended in one word—sun spots. These consist of an umbra or central darkness, surrounded by a less dark penumbra. Mr. Dawes has discovered in some spots even a deeper darkness in the centre of the umbra. Now, if it be correct to suppose that spots are cavities, of which the umbra forms the bottom, and the penumbra the sloping sides, then the umbra ought to encroach on that side of the penumbra which is next to the visual centre of the disc. Professor Wilson, of Glasgow, was the first to remark that spots really behaved in this manner; and his remark has been abundantly confirmed by the Kew photographs taken under the superintendence of Mr. De la Rue. It, therefore, follows that the umbra of a spot is at a lower level than the penumbra; and since luminous ridges, and sometimes detached portions of luminous matter, cross over spots, it must be concluded that the whole phenomenon is below the surface. Again, spots exhibit the rotation of our luminary. If we turn to the south and view the sun, spots are always seen to pass from left to right. Besides the proper motion due to rotation of the sun, spots have also a proper motion of their own, first observed by Mr. Carrington; this motion is also from left to right; those near the solar equator moving fastest. Mr. Carrington also remarked that spots confine themselves to the equatorial regions of the sun. H. Schwabe, of Dessau, has remarked that spots have a period of maximum and minimum nearly every ten years, and General Sabine has found that the year of maximum sun spots is at the same time that of the greatest disturbance of the earth's magnetism.

A fitting supplement to the above lecture is to be found in the second series of Researches on Solar Physics: On the Behaviour of Sun Spots with regard to Increase and Diminution, which has recently been presented to the Royal Society by Warren De la Rue, F.R.S., Balfour Stewart, F.R.S., and B. Loewy, Esq. The object of this research has been to examine the question started by one of the authors of the paper, whether the behaviour of sun spots with respect to increase and diminution could be referred to some extraneous influence. In a table given, showing the behaviour of sun spots from the beginning of 1854 to the end of 1864, it is seen that different spots occurring about the same time on the sun's disc, behave themselves in the same manner; so that if one spot after making its appearance increases until the centre line, another will do the same; or if one spot breaks out on the left or on the right half, the other spots about the same period have a tendency to break out on the same half. The authors suppose that this peculiarity of behaviour of spots can only be explained by reference to some influence from without, and have attempted to answer the following questions:—Is this influence stationary? or if movable, can it be traced to any of the planets of our system?

In answer to the first question, it may be remarked that it cannot be found by investigation that there is any connection between a certain behaviour of sun spots and a certain period of the year, and hence there is no reason to suppose that the external influence is fixed. In the next place does this influence, if movable, move faster or slower than the earth? If faster it will pass over the sun's disc from left to right; but if, on the other hand, the influence move more slowly than the earth, it will move from right to left; so that a tendency of spots to form on the disc will be followed by a tendency to *increase*, not *decrease* after making their appearance. It is shown by a table that a tendency of spots to break out is followed by a tendency of spots to decrease after making their appearance, and it is thereby concluded that the influence moves faster than the earth. This would seem to point to either Mercury or Venus, as the agent in this matter, but the behaviour varies too slowly to be caused by the former. Venus therefore appears to be the influencing agent, and a table is given which seems to show that the behaviour of spots appears to be connected with the position of Venus in such a manner that spots dissolve when that part of the sun's surface in which they exist approaches the neighbourhood of this planet, while on the other hand as the sun's disc recedes from this planet spots begin to break out and reach their maximum on the opposite side. A legitimate deduction from these observations is, that the behaviour of spots is influenced by something from without; and from the nature of the spot-behaviour, the authors conclude that this influence travels faster than the earth; and finally, they find that the behaviour of spots appears to be determined by the position of Venus in such a manner that a spot wanes as it approaches this planet by rotation, and on the other hand breaks out and increases as it recedes from the neighbourhood of the planet, reaching its maximum on the opposite side. The authors do not, however, mean to convey the meaning that Venus is the cause of the ten-yearly period of sun spots, but merely that there is a *varying behaviour* of spots which appears to have reference to the position of this planet.

Proceedings of the Royal Astronomical Society.

The annual Report of the Council of this Society brought before the General Meeting in February last, arrived too late to admit of notice to be taken of it in our last Chronicles. In the mean time much that it contains has ceased to have any particular interest in these pages, and many of its announcements have already appeared in our Chronicles. We shall, however, briefly glance through the report (which occupies 70 pages of the Monthly Notices), and note anything which may appear worthy of record here. From the Proceedings of the various Astronomical Observatories, we extract a few matters of interest. At Greenwich no important changes, instrumental or otherwise, have been introduced during the past year. The connection between the Observatories of Greenwich and Paris, by which the Greenwich Observatory is charged with the Meridional Observations of the Asteroids from new moon to full moon, and the Paris Observatory from full moon to new moon, has been found to afford relief without any loss of valuable observation. During the autumn of last year, Colonel Forsch, Capt. Zylinski, and Doctor Tiele, gentlemen connected with the measurement of the Great Arc of the parallel between Orsk on the Oural, and Valentia on the West Coast of Ireland, were engaged in England in determining the differences of longitude between Greenwich and Bonn, Nieuport, and Haverfordwest.

At the Radcliffe Observatory the Heliometer has been chiefly used for the completion of the re-observation of Struve's *Lucidæ*, of which very few are found to exhibit any conspicuous orbital motion. The meteorological observations have been made and discussed with the same rigour as in preceding years, and the photographic sheets are found very useful in the comparison of storms passing over Oxford and other places, where there are found similar self-recording instruments.

At Cambridge, in addition to the usual work of an observatory, a very complete series of observations has been made for the purpose of determining by means of the method introduced by Professor Challis, the errors arising from the form of the pivots of the transit instrument. With the Northumberland Equatorial, observations have been made of Comet I., 1864, and also of the places of 747 Ecliptic stars. These have been made by means of a new eye-piece, of Steinheil's construction, made by Mr. Cooke, of York, and provided with a square bar micrometer, on a plan devised by Mr. Graham, the first-assistant.

The extensive works now in progress in the immediate neighbourhood of the Liverpool Observatory, have somewhat interfered with the general routine duties of the establishment during the past twelve months. Owing to the land on which it stands being required for dock accommodation, and the impossibility of finding any site on the Dock quays or near the margin of the river, which might not be wanted for dock extension in a few years' time, it has been decided to take the observatory over to the west-side of the river, where the Dock Board possess two acres of land on Bidston Hill, on which there are at present a lighthouse and a telegraph station. These it has been decided to rebuild, and the observatory is also to be erected on this site, where it will be about three miles west of the present building, and about two hundred feet above the level of the sea. The site is favourable for astronomical and meteorological observations; it has the great advantage of security against being built around, or of being required for other purposes, and it is but little over a mile from the upper portion of the Birkenhead Docks. The plans of the new building have been decided on, and Mr. Hartnup hopes to be established in the new observatory by the latter part of the present summer.

From Edinburgh, owing to the absence of the Astronomer Royal for Scotland, upon a scientific expedition to Egypt, no report of this observatory is given.

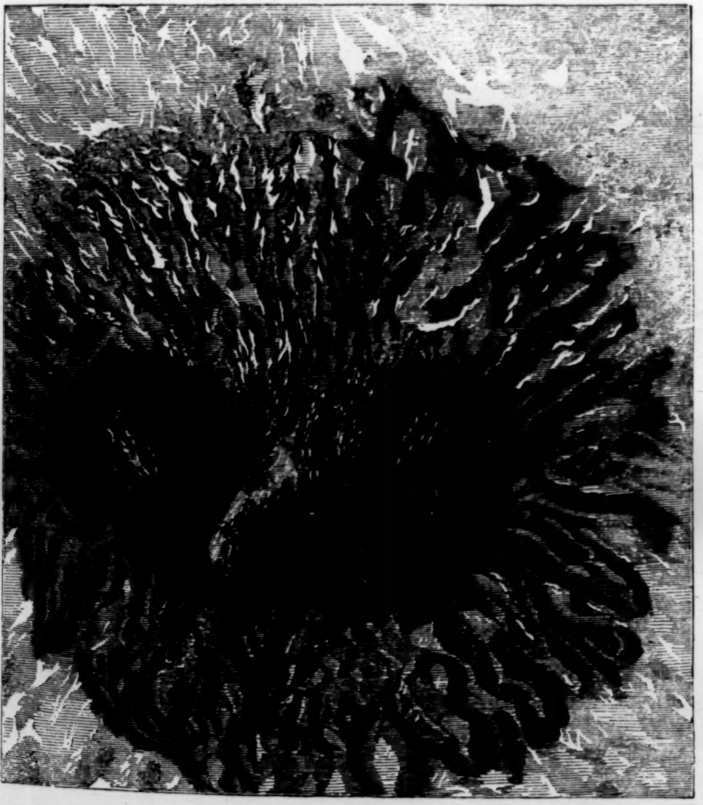
At the Glasgow Observatory, the astronomical observations have been of the usual routine character. There are at present ten public clocks in the city of Glasgow, controlled by a current of electricity from the normal mean-time clock of the observatory, at an average distance of three miles from the controlling source. The Clyde Trustees have also decided upon establishing controlled clocks upon both sides of the river in behalf of the shipping interest, and steps are now being taken for laying down a new electric wire in furtherance of that object.

At the Kew Observatory, besides the valuable observational and instrumental work which renders this establishment so valuable to the man of science, photographs and observations have been taken of the sun's disc, at least two pictures having been taken on every day when this was possible. The results of these labours have been communicated to the Royal Society, and find appropriate record in our astronomical chronicles.

The researches in physical astronomy which have been carried on at Mr. De la Rue's observatory, and at that of Mr. Huggins, do not require notice here, as they are treated of at length elsewhere. The latter portion of the report is devoted to a review of the progress of astronomy during the past year. In it, however, we do not notice anything of importance which has not been recorded in these pages.

At the conclusion of the report, and in the form of a supplement, is given a summary of the important results of Mr. Lassell's observations at Malta, in the form of a letter. It will be sufficient here to indicate that in addition to the discovery of many nebulæ heretofore unobserved, and the careful re-delineation of others observed in England under less favourable atmospheric circumstances, and with telescopes of far less optical power, Mr. Lassell, after the most careful scrutiny, comes to the conclusion that the number of the known satellites of Uranus must be reduced from eight to *four*, and those of Neptune from two to *one*.

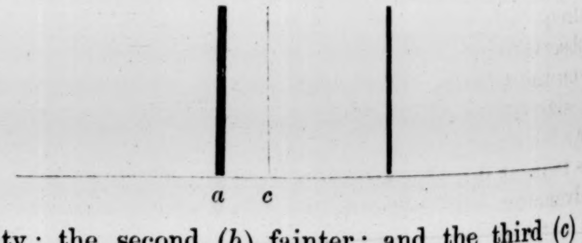
At the March meeting of the Society an important letter was read from the Rev. Father Secchi to Mr. Warren De la Rue. The author had been observing with a new prism for the solar eye-piece, forwarded to him by Mr. De la Rue. It consists of a Herschelian prism, in which the reflecting surface makes an angle of 45° both in the incident ray and the axis of the eye-piece, and the second surface is at right angles with the transmitted pencil. With it observations may be made with comfort and ease, even for a very long time, without any fatigue to the eye, although with the full aperture. An examination of one very large spot gave Father Secchi a very good sight of the so-called *willow-leaves.* He observes that there is not in any place any uniform tint, but an agglomeration of oblong and white bodies, having one-third or one-fourth of a second of arc in breadth, and of very different lengths. It is very difficult to compare them to any terrestrial object, but the name of leaves is not very badly chosen. The accompanying woodcut, which has been copied by the kind permission of Mr. De la Rue, gives some idea of the appearance of this spot, although the writer thinks that it is quite impossible to delineate it as it really appeared. What is very singular is, that these white bodies in some places agglomerate together so thickly that they constitute a continuing stream, but in general they are broken. These bodies are more apparent and separated when the spot is very enlarged, as it is in the present case. The general body of the sun is also made up of these oblong bodies, but of every form and dimension. A great many black pores seem to show that the photosphere is not a continuous stratum, but at the first sight it appears made of little



lumps, like so many little cumuli of cotton wool. On contemplating this kind of phenomena, the Rev. author says that he cannot divest himself of the opinion that the photosphere is really made up of clouds, and that the luminous stratum is actually constituted like our clouds, the only difference being that the clouds on the earth are of watery drops or crystals, and in the sun they are of some other substance in a state of suspension in the transparent atmosphere of the sun, like water in our own atmosphere. This opinion is enforced on observing the dissolving part of a spot, which presents all the phenomena of our cloudy sky; there are the forms of *cumuli*, of *cirri*, of *strati*, so perfectly equivalent to those of our earth, that sometimes the aspect of our clouds and of the hind part of the spot in the field of the telescope is exactly the same. What is very singular are the small bits of luminous photosphere in the middle of the nuclei, of which there is an example in the figure. The edge of the spot seems perfectly comparable to the edge of the cumuli when in summer time they flow to fill up the chasm which is in the centre or opening of the cloudy stratum.

This article of Father Secchi's brought forth a note from Sir J. F. W. Herschel, Bart., stating that he does not think the *willow leaves* are clouds in the ordinary sense of the word, he believes them to be *permanently solid matter*, having that sort of fibrous or filamentous structure which fits them when juxtaposed by drifting about and jostling one against another to collect in blocks, as *flue* does in a room. In answer to the question, Why are these, and these only, luminous? the author replies, Because they are solid and they float (at the level determined by their density) in *gaseous* or transparent liquid, or intermediate matter of immensely high temperature. The non-luminosity of the medium in which they float being quite sufficiently accounted for by supposing it of *colourless transparency*, colourless gases or transparent liquids giving off no heat from their interior. This is, in fact, the theory stated in Sir J. F. W. Herschel's article on Solar Spots, published in our Number for April, 1864.

The next communication consisted of a letter from Father Secchi, on the spectrum of the Great nebula in Orion; apparently not knowing that Mr. Huggins had already sent a paper on this subject to the Royal Society, the Reverend Father hastens to give the results which he has met with. The whole spectrum of this nebula reduces itself to three lines: one (*a*) tolerably strong, and which is seen wherever there is nebulosity; the second (*b*) fainter; and the third (*c*) still more faint, and very near to (*a*). The group is situate between the Sodium



ray D and the Strontium blue line. Quoting an observation of Mr. Huggins in which it is shown that in *α Orionis*, there is no dark line corresponding to the above line *b* (coinciding with Frauenhofer's F). Father Secchi infers that we have in that star the bright ray which is found in the nebulæ. Can this star, he asks, be a body intermediate between the perfectly-formed stars and the nebulæ? In the discussion which followed this note, Mr. Huggins stated that he could not agree with the ingenious conjecture of Secchi, that the star *α Orionis* may be a body intermediate between a nebula and a fully-formed sun, because the dark line of absorption corresponding to F is wanting in its spectrum. The light of the star emanates, as its spectrum shows, from incandescent solid or liquid matter, and therefore necessarily contains rays of all refrangibilities, and it is the presence of bodies in its atmosphere which is indicated by the dark lines of absorption. The absence therefore of a dark line corresponding with F and also with one of the bright lines of the nebula is a proof, not that the gas in the nebula from which the light of that particular refrangibility emanates is present in the atmosphere of the star, but, on the contrary, that this particular gas is not one of the constituent elements at *α Orionis*. The closely-crowded lines of the spectrum of the star appear to prove that it contains elements as numerous as those which exist in the sun and in the brighter stars. The absence of the lines of hydrogen corresponding to C and F is scarcely a sufficient reason for degrading this star to a lower cosmical rank. At the request of the President, Mr. Huggins then gave an account of the most recent of his researches on the application of prismatic analysis to the light of the nebulæ. This was an examination of the Great nebula in the sword handle of Orion. The results have already been before our readers.

Some important steps have been gained and some real contributions made to exact science during the past year in the department of Meteoric Astronomy. A summary of these by A. S. Herschel, Esq., formed the next important communication made to the Society. As regards the height of shooting stars it appears from a comparison of several hundred observations dating from the end of the last century, that it may be stated respectively at 73 and 52 miles at first appearance and disappearance above the surface of the earth, with a probable error of not more than three miles. The average velocity of shooting stars in sixty-six instances is 35 miles per second. In this respect fire-balls resemble shooting stars, but they differ from them in penetrating more deeply into the atmosphere; should they arrive within 20 miles of the earth's surface a violent concussion is usually produced, and stones are not unfrequently precipitated from the meteor. One of the most remarkable observations of a fireball on record was made by Dr. Schmidt, at Athens, on the morning of the 19th of October, 1863. A fireball of surpassing size and brilliancy was examined for 14 seconds by Dr. Schmidt, in a telescope with a magnifying power of eight diameters. The meteor was twin or double, attended and followed by a tribe of lesser meteors advancing side by side together, with parallel motions of translation, until the whole were extinguished. Respecting the origin of aërolites, it has been found from a microscopic examination of the mixed minerals of which they consist, that their crystals differ in some essential particulars from those of ordinary volcanic rocks, but their consolidation must have taken place from fusion in masses of mountain size. The planetary velocity (at least 15 miles per second) of the meteor, which produced the recent aërolites of Orgueil, greatly exceeds the ballistic forces which can be supposed to reside on the surface of the earth or moon. We are therefore compelled to give a wider range to conjecture with regard to aërolites, and to suppose that they are projected from small planets near and within the orbit of the earth. Aërolites commonly fall in the daytime. They circulate round the sun in such countless numbers, or else they bear such close a relationship to the earth that they in all probability strike the earth daily in its path.

Mr. A. S. Herschel has also contributed an elaborate article on the "Radiant Points of Shooting Stars." We regret that it would be impossible to condense this article so as to give a good idea of the results at which the author has arrived.

The next paper was by J. Joynson, Esq., "On the Appearance of Mars." This subject has been so ably treated in the former part of this number by Professor Phillips, that no further mention of it is required here.

The Number of the 'Monthly Notices,' which contains a report of the March Meeting of the Society, is illustrated with a Photo-engraving of a Lunar Photograph, printed from a plate untouched by the graver. The picture, one of the most successful of its kind we have ever seen, has been taken by Paul Pretsch's process; but the original negative is apparently so perfect, that it is a matter for regret that Mr. Fox Talbot's photoglyphic process had not been adopted as a means of multiplication, as by this scarcely any of the fine definition would have been lost. It will be evident that by a process of this kind we have at our command a means of procuring prints of the lunar or solar surface, having all the permanence of ordinary engravings; and these methods, if used to reproduce photographs of large dimensions (thirty-eight inches in diameter, for example), would give such reliable charts as with any other mode of procedure it would be impossible to obtain. Much of the half tint is lost; but, nevertheless, so much of value is retained as to show that some such process is deserving of more general adoption for scientific objects than it has hitherto received.

At the conclusion of the meeting, Admiral Manners, who occupied the chair in the absence of the president, remarked upon the present activity and good condition of the Society. The communications are very varied in their character; the general range of the papers presented shows that observers and those who communicate their observations to the Society, are alert and alive to the importance of quick and rapid communication to this centre of astronomical science. It is also a subject of congratulation to find that, whatever communications may be made, there are members present who are able to add to the value of the communications by their remarks, and who show that they understand the subject fully, and are quite acquainted with its progress.

At the April Meeting of the Society, a paper "On an Aluminium Bronze Transit Axis," and on "Certain New Methods of Adjusting Transit Instruments," was brought forward by Lieut.-Colonel A. Strange, F.R.S. Three years ago this gentleman presented to the Society a paper advocating the use of aluminium bronze, as a substitute for gun-metal in astronomical and surveying instruments. Since that time the alloy has been used in the large instruments now being made under his supervision for the great Trigonometrical Survey of India. The experience gained during the construction of these shows that the alloy is not fitted to receive graduation, both on account of the metal tarnishing more than was at first expected, and owing to the difficulty of obtaining absolute soundness of surface in casting of this metal. At first also the use of the alloy was threatened with further limitation. The early experiments in casting it in large masses resulted in internal air-holes to an extent to which other metals are less subject. This hindrance to the more extended use of the alloy has, however, yielded to scientific effort, and in proof of this statement there was exhibited to the Society the axis of a transit instrument formed of aluminium bronze. It was 33½ inches between the bearings; the central cube is 9½ inches by the side, and the thickness of the metal is only 0·15 of an inch; the whole weighing 56½ lbs. This admirable specimen of scientific founding was from the works of Messrs. Cooke, of York, who are one of the few optical firms (if not the only one) in England who do the whole of their own founding. Having regard to the great rigidity of the alloy (three times that of gun-metal), and the ingenious system of internal strengthening webs, there is little doubt that this is the stiffest transit axis in existence.

In the second part of his paper, the author submitted to the Society certain modifications which he proposed to introduce in the two transit instruments, to one of which the axis exhibited belonged. These came under the heads: I. Adjustments of axis for azimuth and horizontality. II. Mode of applying the level to the axis. III. Mode of examining the collimation error. This latter is intended to be effected by means of a mercurial trough, as being a preferable arrangement, for a travelling observatory, than by means of fixed collimators. As it is difficult in a field observatory to prevent tremors and disturbance of the mercury by currents of air, Mr. Cooke proposes the following arrangement:—A disc of glass having plane and parallel surfaces will float on the mercury and protect it from disturbance. The lower surface of the disc, in contact with the mercury, will form a brilliant plane-mirror to be used in the same manner as the usual unprotected surface of mercury. Certain mechanical conditions are imposed by the terms of the problem. 1st. The two surfaces of the disc must be plane; 2nd. They must be parallel; 3rd. The glass must be of equal density throughout. Treating the disc by optical methods, Mr. Cooke expects to fulfil these conditions.

The next paper brought forward was a long mathematical discussion on the "Lunar Theory," by Professor Cayley. This defies condensation.

Mr. F. Abbott communicated a note on the variable star η *Argus* and the surrounding nebulæ. He is satisfied that continued changes are constantly taking place in this nebula, and that it is gradually breaking up into stars. In former notes he described the so-called dark space as resembling in shape a clearly-defined "crooked-billet;" it now assumes a very different form, and what is singular, Sir J. Herschel describes ϰ *Crucis* in glowing colours, "like a rich piece of jewellery;" but he is silent as to the colours of the stars around η *Argus*. In former notes the author mentioned many of them as being of a ruddy colour; but now they are of decided colours—blue, green, and red, the two former predominating. If the telescope is turned from one object to the other, it will be seen that, although Sir J. Herschel has not overdrawn the beauty of ϰ *Crucis*, the object η *Argus* is now much more superb, η standing out sharp and clear, amidst a large field full of richly-coloured gems with only a very small patch of nebulous matter seen under the telescope. In February last, during the period of full moon, the position of η *Argus* was distinctly seen with the naked eye, by the white light that surrounded it, although the star could not be seen as a point, nor could the position of *Nebicula Major*, *Nebicula Minor*, the *Via Lactea*, or any other nebula be seen at the time. This appears plain proof that the objects composing the nebula around η *Argus* are now of a larger character, and more refulgent than nebulous matter in general.

We can make the same remarks with reference to a paper, which was next read, by C. G. Talmage, Esq., "On an Appearance presented by the Spots on the Planet Mars," that we did in respect to the paper by Mr. Joynson on the same planet.

The concluding papers were devoted to observations on a large comet, which was visible at the commencement of the year in the Southern hemisphere. They are by J. Tebbutt, jun., Esq., Windsor, New South Wales; R. C. J. Ellery, Esq., Melbourne Observatory; and F. Abbott, Esq., Hobart Town.

III. BOTANY AND VEGETABLE PHYSIOLOGY.

M. Planchon has made some observations on the Flora of Montpellier, from the 15th century up to the present date. The neighbourhood of that city possesses special interest as regards botanical geography. For three centuries celebrated botanists have made excursions in the locality, and have left traces of their observations in their writings and herbaria. By this means we can observe the introduction and disappearance of certain species, such at least as have well-characterized forms. Moreover the traffic in wool has introduced into the place called Pont de Juvenal foreign plants, which have frequently attracted the notice of botanists. M. Planchon has made use of numerous documents already published, as well as of his own observations, to bring out the effects produced on the vegetation of Montpellier, by the various causes which have had a tendency to alter it since the 16th century. Around Port Juvenal 458 species have been successively introduced. The botanic garden of Montpellier has contained, from the time of Richer de Bellerat to the present day from 1,200 to 5,500 species, the seeds of which might accidentally be scattered beyond its boundaries. The ballast of ships has been deposited in many littoral situations, and that ballast in many cases contained seeds. The wind, birds, and currents, have transported seeds from various places, far and near. Many botanists have scattered seeds in different places. At the same time, culture, drainage, the destruction of forests, and the avidity of collectors, have caused the disappearance of many species. Notwithstanding all these causes of change in the Flora, the following are the definite results: Five species at most have disappeared from the neighbourhood of Montpellier, and not one of them has been destroyed by botanical collectors. This shows how needless were the fears of those who lately protested against the prizes for collections offered by the Horticultural Society of London. The attempts at introduction by man have had effect only in establishing three aquatics, of which *Jussiœa grandiflora* is the most extended. Culture has brought into the country eight species, but all of these have been limited to the place where they were introduced. The import of wool has only given rise to the appearance of one species (*Onopordum virens*). Ballast has brought 3 species, which are still very limited. There are only 15 species which an observer, ignorant of their origin, might look upon as indigenous. Of these 15 species, 11 come from America, 1 from the Cape of Good Hope, 2 from the East, and 1 from Europe. The American species most diffused are *Œnothera biennis*, *Erigeron canadense*, *Amaranthus albus*, *A. retroflexus*, *Xanthium spinosum*, *X. macrocarpum*, and *Bidens bipinnata*. Man has almost always been the direct or indirect agent in the introduction of the species.

M. Planchon has also studied the fossil Flora of Montpellier. He finds that changes have taken place in the Flora at a former epoch. He has found in the quaternary formation of Montpellier 30 species, all of which exist at the present day, the greater part in the same locality. The laurel was the predominating shrub. It no longer exists in a wild state round Montpellier; but it was found two centuries ago in the locality of Castelnau, and it exists still at the present day on the northern face of the Pic de St. Loup and on the rock of Arcs. Three species out of 30 are no longer found in the country; these are,—*Fraxinus Ornus*, *Pinus Laricio*, and *Acer Neapolitanum*, the nearest localities for which are Corsica or Italy. On the contrary, several species, abundant at present in the dry gravelly soils of Montpellier, have not been found in the quaternary formations; for instance, *Quercus coccifera*, species of Cistus, Rosemary, Thyme, and Lavender. Planchon has noticed the same fact in similar formations in Provence and Italy, so that it is not the result of a purely local change. The plants of dry localities seem to have become more rare in the South of Europe during the quaternary epoch. In other words, the humidity appears to have been greater, and more generally diffused, as might have been expected in a glacial epoch. When we compare the formations observed in Provence by Saponta, and in Italy by Gaudin, and those at Montpellier, we find that in the latter all the species exist at the present day, whilst in the former there is a mixture of extinct species. The quaternary formations at Montpellier appear, therefore, to belong to a more recent epoch.

In the Montpellier formation we find figs similar to those of the wild fig and leaves of the vine, which indicate the existence of these plants in the South of Europe, anterior, in all probability, to culture. On the other hand, the Olive is wanting.

It is stated that in France cases have occurred in which inoculation with Oidium Tuckeri, or the fungus which causes the vine disease, has proved fatal to human beings. Wounds accidentally made with the instrument used for cutting off the diseased vine shoots have presented, according to Dr. Collin (Medical Inspector of the Mineral Waters of Saint-Honoré, Nièvre), marked evidence of poisoning. In some cases the persons thus wounded have died in from twenty to twenty-five days, notwithstanding the most energetic treatment. Messrs. Desmartes and Bouché, of Vitrany, have also concluded, from their experience, that deleterious effects are produced by the Oidium, but they seem rather disposed to establish a coincidence between the epidemic development of the Oidium and a greater frequency of certain forms of inflammation of the mucous membranes. The subject has been submitted to the consideration of the Academy of Medicine in Paris.

Dr. Alexander Dickson has recently examined the morphological constitution of the Andrœcium of Mentzelia, and its analogy with that of certain Rosaceæ. He gives the following result of his investigation of the development of the stamens in Mentzelia aurea. From the fact of the greater number of the stamens not appearing until after the development of the carpels, as well as from a consideration of the peculiar arrangement of the stamens, he believes that here the Andrœcium really consists of five compound and confluent stamens superposed to the sepals. Dr. Dickson is of opinion that the only essential difference between Mentzelia and its allies, on the one hand, and Loasa and its allies on the other, is, that in the former the evolution of staminal lobes is centripetal, in the latter centrifugal; both series of genera agreeing in having five compound stamens superposed to the sepals. This difference in staminal evolution does not appear to Dr. Dickson sufficient to justify the breaking up of the old order Loasaceæ, as has been done by Payer in his 'Leçons sur les Familles Naturelles des Plantes.' In the Rosaceæ, where Payer had recognized a similarity in staminal evolutions to the Mantzeliæ, Dr. Dickson believes that those Andrœcia whose development has been examined may be arranged under two types:—I. Aremonia type; stamens superposed to the sepals, with or without a true corolla. Examples: Aremonia, Agrimonia, Sanguisorba, Poterium. In Aremonia and Sanguisorba the stamens are simple; in Agrimonia they are compound and distinct; and in Poterium, compound and confluent. II. Alchemilla type; stamens alternate with the sepals; no true corolla. Examples: -Alchemilla, Rubus, Rosa, Geum, Fragaria, &c. In Alchemilla the stamens are simple. In Rubus and the others the stamens are compound and confluent, with their terminal lobes developed as petaloid staminodes (the petals ordinarily so called) analogous to the petaloid staminodes forming the inner corolla of Bartonia, an ally of Mentzelia.

Dr. Thomas Anderson reports on the state of the Cinchona plantations at Darjeeling, in February, 1865. He states that the month has been less favourable than January, as the cold, which has been quite as great as in January, has been accompanied with a very dry state of the atmosphere. Hail fell on the 3rd of the month and rain on five days, but with the exception of the 25th and 26th of the month only in slight showers, which did no benefit whatever to the Cinchona. The slight increase in growth took place almost entirely during the last five days of the month, with the exception of the lowest plantation, where about the 17th the plants began to show the first symptoms of the return of spring. At the first plantation (5,500 feet above the sea) the temperature has been very low, causing the destruction of at least three plants of Cinchona Pahudiana, and affecting a few of Cinchona officinalis. At the second plantation (4,350 feet above the sea) hoar-frost occurred in several nights in February, but no damage has been done to any plants at this elevation. Observations on the temperature of the air have been made with more or less regularity during the month at the 3rd, 4th, and 5th plantations. At the fourth plantation (2,550 feet above the sea) the maximum and minimum temperature in the shade was recorded every twenty-four hours during the month. The mean maximum temperature for the month at this elevation was 66°18, the mean minimum 47°93, and the monthly mean temperature 57°05. At the fifth, the lowest plantation (altitude 1,825 feet) fewer observations were made, as the plantation was visited daily by the person observing. The results from the detached observations there give 71°56 as the mean maximum, and 47°77 as the mean minimum, 59°5 as the mean temperature of the month.

The total number of plants, cuttings, and seedlings in the Government plantation at Darjeeling, on 1st February, 1865, is as follows:—Cinchona succirubra, 4,780; C. Calisaya, 23; C. micrantha, 944; C. officinalis and vars., 19,329; C. Pahudiana, 5,092—total, 30,168.

Dr. Moore, of Glasnevin, has recently visited the station in Galway, for Nectinea intacta. He saw about 40 plants in the locality; they grew on a dry bank close to limestone.

Dr. Dickson thinks that there are two marked varieties of Pinguicula vulgaris, in Scotland, distinguished by the size and form of their leaves, as well as by their flowers.

The Pitayo Cinchona has attracted attention of late, and a Report

has been drawn up on the subject by Mr. Robert Cross,* of which the following is an extract :—

Mr. Clements R. Markham having been impressed with the importance of procuring seeds of the species of Cinchona which grow at and near Pitayo, New Granada, obtained the sanction of the Secretary for India to employ Mr. Cross in the service. The first writer who described the country round Popayan and Pitayo was the Spanish conquistador, Cieza de Leon. He accompanied the invading discoverers, who, starting from Darien in 1536, ascended the valley of the Cauca, and reached Popayan. The next author who treated of this region was the humane and generous but unfortunate Adelantado Andagoya, who was at Popayan in 1544. Ulloa, in his travels, gives a brief general account of the Popayan province. The only modern writers who have preceded Cross are Humboldt, Caldas, Karsten, and Vigne. Humboldt crossed the paramo of Quindiu, ascended the valley of the Cauca to Popayan in 1801, and went thence to Pasto and Quito. During his stay at Popayan he made an excursion to the village of Purace. The learned Caldas was a native of Popayan. He was a good botanist and an excellent observer, and he knew the country well. Most of his writings are, unfortunately, still in manuscript, but some of them have been printed in the 'Semanario de la Nueva Granada,' amongst which there is a very valuable geographical memoir written in 1807. Dr. Karsten was for some years in this part of South America investigating the botany of the Andes. He made notes on the medicinal Cinchona barks of New Granada. Finally, Mr. Vigne travelled for his amusement from Quito to Bogota, going over exactly the same route as Cross, and his travels were published in 1863. Among these writers, Caldas and Vigne are the only ones who have gone over the same ground as Cross, and no one had given any account of the actual Pitayo forest previous to Cross's visit. Mr. Cross remarks that most persons who have written on the Cinchona of the Andes represent it as flourishing amidst perpetual torrents of rain and mist, without scarcely ever enjoying a moment of sunshine. He states that this is a mistake. No Cinchona could live in such a climate, nor, even if planted in similar situations, could the trees ripen their seeds, for a certain amount of dry weather and sunshine is necessary for the ripening of the capsules, and for their bursting in order that the seeds may fall to the earth. The Cinchona climate is certainly moist for about six or eight months of the year, and in cultivating this plant it is expedient to seek very humid situations, because the mountains of India do not appear to receive the same amount of moisture as the lofty elevations in America. Nevertheless it will be understood that the natural climate of the commercial Cinchona has been misrepresented by most South American travellers. The Pitayo Cinchona differs essentially from the C. lancifolia of Karsten in being a more slender tree, often found formerly from 60 to 70 feet in height, but rarely more than 18 inches or 2 feet in diameter, with very slender branches, bearing small lanceolate leaves, which before falling always assume a purple or deep red colour. The C. lancifolia to which Karsten refers extends over a wider tract of country than any other Cinchona on the Andes. This tree, however, is much more massive, and bears considerably larger leaves than those of the Pitayo Cinchona. This large-leaved Cinchona inhabits the western slopes of the Cordillera Orientale, in situations presenting conditions favourable for its development, between Pasto and the city of Santa Fè de Bogota; while the finer kinds of Pitayo bark are limited to a

* 'Report to the Under Secretary of State for India on the Pitayo Cinchona,' &c. By Robert Cross. 8vo. London, 1865. pp. 60.

few square miles of steep forest-covered slopes to the northward of the volcano Purace, which belongs properly to the central Cordillera. The map of the Cinchona region of New Granada, lately made for Dr. Weddel, is very incorrect. It represents certain tracts of country as mountainous, and as covered with Cinchona forests, while in reality they are hot arenaceous plains, or savannas covered with low spreading leguminous trees, where no Cinchona ever grew. Karsten states that the bark is not taken from the roots of the C. lancifolia, which, in most instances, is true; but this is not the case with that of Pitayo, the bark from the roots of which is much more valuable than that from the trunks and branches. Further, he asserts that the C. lancifolia is never likely to become scarce, and that the continual cutting of the Cinchona trees will rather augment than diminish the number of plants, and this may be true concerning his C. lancifolia, about which no one cares much, as the yield of quinine is often too small to cover the expense of collecting; but as regards the Pitayo bark there is one thing very certain, that at the present time there is more difficulty in collecting one pound than there was formerly in collecting one hundred-weight. The Pitayo bark will very probably be found the best of all the species for cultivation, as it is said to grow very rapidly, which is a matter of great importance. It may certainly be barked when it is six feet high, although it would not be an advisable practice to do so before the trees are at least 30 feet high. Bark taken from large trees in Pitayo was said to give nearly 4 per cent., while bark taken from the roots of the same trees gave 5 per cent. of quinine. All the bark taken from Pitayo is said to be sent to France. The bark sold in England under that name is not true Pitayo bark, but comes from the mountains which border on the valley of the Magdalena, and from Almaquer and Pasto, and is certainly different from the C. lancifolia of Karsten, which as regards quality is very inferior to that of Pitayo. True Pitayo bark may be known in England by not being much thicker than common window-glass—because it is all taken from small plants, the large trees having been destroyed long ago, and by its being full of earthy particles, on account of so much bark being taken from the roots of the plants. The Cinchona alluded to by Karsten is rarely collected when less than one-fourth of an inch in thickness, but it is sometimes seen nearly an inch thick after the epidermis has been scraped off. Professor Jamieson, of Quito, analyzed the Pitayo bark brought from the locality from whence the seeds were taken, and found it to contain 3·2 per cent. of quinine. There is therefore little doubt that this species, and the Cinchona officinalis of Loxa will prove among the best for cultivation. The climate is like that of Loxa, and even the vegetation of both regions bears a close resemblance to each other. The Andes of South America, from the southward of Loxa to the city of Santa Fè de Bogota, present great diversities of character, and even each particular tract of country possesses its own peculiar and distinctive features. Around Loxa many of the mountain ridges appear as if they had been scraped from top to bottom, and they are separated by deep ravines, on whose naked and almost perpendicular sides grow only a few stunted Cacti and Agaves. To the south-west of the valley of Catamayo, dry, rainless deserts extend to the frontier of Peru. However, on passing to the northward of Assuay the mountainous regions are covered with a dense vegetation; and above the forest limit are extensive grassy paramos, while higher still rise rounded elevations, or conical peaks, covered with perpetual snow. Beyond Pasto, the loftier regions bear an arborescent vegetation; but the hot, low-lying plains are mostly covered with coarse grass, or low-spreading Leguminosæ. From this point, until one reaches the great valley of the Magdalena, the mountainous region presents a most savage aspect of stupendous precipices, which form a kind of wall along the base of the eastern and central Andes. Throughout this vast territory, but especially along the course of the central Andes, runs a long line of burning mountains, active spouts of hot mineral water and sulphurous vapour, and bubbling mud volcanoes. Don Narciso Lorenzano remarks that the principal motive which induced the Government of India to commence Cinchona cultivation, after overcoming so many difficulties, was the fear that the Quina trees would be extirpated in consequence of the waste that is allowed in the woods, where they are destroyed by the barbarous method of pulling up the roots. Fortunately this destructive method, which, without any doubt, would extirpate this precious plant in a few years, is only practised in the forests of Pitayo, where it is due to the immoderate desire for making money which has taken possession of the Indians, who own the greater part of the land. But in none of the other establishments for the collection of bark in New Granada has a similar practice been adopted. On the contrary, beneficial rules are observed for the conservancy of the woods. The method consists in leaving a part of the trunk, about three feet in height, whence shoots may sprout, and in clearing away the surrounding trees to enable the rays of the sun to penetrate. By this means most of the trees that are cut down quickly shoot up, and, the rays of the sun penetrating to the cleared ground, the seeds which fall from the trees germinate freely. This result gives us full confidence that the good kinds of Quinas which exist in this country will be permanently preserved. We may conclude that there need be no fear that humanity will see itself deprived of this precious medicine, seeing that as well in Bolivia, as in Peru, Ecuador, and New Granada, the rule of cutting the bark according to a fixed plan is observed, and care is taken that the woods are replenished with increased numbers of plants of the best species, while some experiments have been made in forming plantations on lands where the best conditions for their growth are found. From all this we hope that in a few years we may see valuable results.

M. Thielens, in a communication on the plants of Belgium, mentions the following additions to the Flora in 1864:—Asperula glauca, Corallorrhiza Halleri, Carex depauperata, C. paradoxa, and C. ornithopoda.

On examining the flowers of Fumariacæ in their early development, M. Godron finds them quite regular, but flattened from before backwards, as if they were compressed between the axis of inflorescence and bract. They preserve this regularity in Diclytra, Adlumia, and Dactylicapnos. In these three genera, the two external petals, placed laterally, undergo during development an important modification. The base of each is prolonged into a short and rounded spur, and the two nectariferous appendages become finally quite regular. The two sepals placed superior and inferior, also remain perfectly regular.

Again in the Genera Fumaria and Corydalis, only one spur is developed so as to render the flower irregular. This spurred petal becomes larger than its antagonist. Mr. Godron has examined Corydalis solida, Sm. and C. cava Schweigg, in their early condition, while still under ground. He traces the abortion of one of the spurs in the petals to the flowers during their development being compressed at the base on one side only. In this way development of the nectary and its appendages is prevented. M. Godron made experiments with the flowers of Diclytra, so as to compress one of the petals at the base during its development, and he thus rendered it like Fumaria with a single spurred petal.

In Diclytra and Adlumia the spurs develop at a later period than in Fumaria, and in such a way that the raceme in elongating separates the flowers from each other, and allows the free and equal formation of spurs.

The regular form sometimes continues in the Fumaria and Corydalis. M. Godron has seen Corydalis solida assuming a pelorian form by two or even four petals becoming spurred or calcarate. The flowers in this case are sterile.

Inflorescence of Cruciferæ.—Bracts are generally wanting in the racemes of Cruciferæ. In some of the characteristic species we find bracts occasionally in the lower flowers. In Sisymbrium supinum, L., all the flowers are produced with a pinnatifid bracteal leaf, and the same is the case with Sisymbrium hirsutum, Lagasc.

Brassica oleracea has been seen with large oblong bracts in connection with its lower flowers, while smaller bractlets occurred at the upper part of the raceme. Similar phenomena have been observed in Erysimum cheiriflorum, Wallr. Arabis Turrita, L., Hesperis matronalis, L., Bunias orientalis, L. Sometimes the lower and middle part of the inner face of the bract becomes united to the base of the peduncle. This has been noticed in Iberis sempervirens, L., and in other Cruciferous plants. Sometimes when the bracts are completely wanting, there are traces of the decurrence of leaves at the base of the naked peduncle.

Godron says that, 1st, the quaternary type, with two rows of stamens, is the normal condition of Cruciferæ; 2nd, that the absence of bracts, and the greater or less flattening of the peduncle; the more or less depressed form of the flower bud; the slight irregularity of the calyx, the absence of two stamens in the outer verticil of the andrœcium, and often of the two glands on which they rest, and finally the abortion of two carpellary leaves, are determined by a pressure which is exercised from within outwardly on the flowers of Cruciferæ; 3d, this pressure is owing to the accumulation of flowers which are developed in great numbers at the summit of the Inflorescence in its corymbiform state, and which are naturally restrained or hindered in their evolution, as well as to the resistance which is presented to this expansion by the accumulated leaves which surround the inflorescence at its origin.

IV. CHEMISTRY.

(*Including the Proceedings of the Chemical Society.*)

Except in organic chemistry, and here only in those researches which interest but the most advanced chemists, there is little of importance to report. It would be wrong, however, in an English Journal to pass without mention the valuable papers presented to the Royal Society by Messrs. Frankland and Duppa, "On the Acids of the Lactic Series, and on the Synthesis of Butyric and Caproic Ethers from Acetic Ether." No less valuable is the paper "On the Hydrocarbons of the Series $C_n H_{2n} + 2$," contributed by Mr. C. Schollemmer. All these papers throw important light on the constitution of the so-called organic compounds, and will be studied with much interest by all who watch the wondrous development of this branch of chemistry.*

In inorganic chemistry there are a few things of scientific and technical interest to which we may more particularly refer. As a curious experiment and striking illustration of the play of affinities, we may notice a reaction described by J. Schiel.† Into a stoppered bottle filled with perfectly dry chlorine, he introduces a sealed tube containing peroxide of silver. He then shakes the bottle and breaks the tube, and now in a few seconds finds that the bottle is filled with oxygen, which the chlorine has replaced. Peroxide of silver is rather difficult to produce, but the same experiment may be shown with the oxide, a longer time being allowed for the displacement of the oxygen. To succeed, perfectly equivalent amounts of chlorine and the oxides must be employed, or the latter must be in excess.

A new and very easy way of obtaining oxygen has been recently described by Fleitmann.‡ He takes a clear solution of ordinary chloride of lime (hypochlorite) and adds to it a mere trace of freshly-prepared moist peroxide of cobalt, and then heats the mixture to 70° or 80° C. At this temperature oxygen is freely evolved, and the whole of the hypochlorite is reduced to chloride of calcium. According to the author the peroxides of cobalt have a variable composition, and to explain the above reaction he supposes that a lower oxide abstracts oxygen from the hypochlorite to form a higher oxide, which is immediately decomposed again into the lower oxide and oxygen. The action of the oxide of cobalt is thus seen to be exactly similar to that of nitric oxide in the manufacture of sulphuric acid.

In connection with the above we may mention that Winkler appears to have proved the existence of cobaltic acid, CoO_3,§ which he finds to be a very unstable body. A potash salt of the acid is obtained by boiling one part of spongy cobalt with one part of caustic potash dissolved in three parts of water, until a dark blue solution is procured. The addition of sulphuric acid to this solution liberates oxygen, protoxide of cobalt being precipitated. Sulphurous acid is converted into sulphuric, which combines with the protoxide of cobalt.

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* All the above papers will be found in the 'Proceedings of the Royal Society,' vol. xv. pp. 164, 191, 198.

† 'Annalen der Chemie und Pharmacie,' December, 1864.

‡ Ibid., April, 1865, pp. 64.

§ 'Journal für prakt. Chemie,' vol. xc. p. 213.

The decomposing action of lead upon pure water has been illustrated by an experiment of Stolba,* who found that on boiling pure water with a relatively large quantity of lead in foil or granulated, hydrogen was somewhat freely evolved, and a strongly alkaline fluid remained in the flask.

Runge has described † the action of sodium amalgam on some metallic salts. Ferric and chromic chlorides he found to be quickly reduced to ferrous and chromous chlorides; in time the whole of the chlorine was withdrawn and iron and chromium amalgams were obtained. The chromium amalgam was a fluid and very unstable compound.

One of the most original and important recent contributions to chemical knowledge we have to notice is the paper presented by Mr. Gore to the Royal Society "On the Properties of Liquefied Hydrochloric Acid Gas." Anhydrous hydrochloric acid the author found to have no acid properties. Solid extract of litmus dissolved but slightly in the liquefied acid forming a purple or inky solution. Metals which dissolve easily in a dilute solution of the acid were scarcely affected; even caustic lime remained in the liquid unattacked. Those oxides attacked were but slowly converted into chlorides; the same was observed with the carbonates, but no bubbles of gas were seen to escape from the liquid. The latter circumstance may be easily accounted for, however, since the author has shown in a former paper that hydrochloric and carbonic acids may be condensed together, forming one liquid.

The properties of the new metal, Indium, discovered by Reich and Richter (*see ante*, p. 87), have been further investigated by Winkler.‡ The metal resembles platinum in appearance. It is soft like lead, and may be easily cut with a knife. Heated to bright redness, it volatilizes and burns with a blue flame, forming an oxide InO, which is deposited as a yellow powder. The reactions of the metal, as given by Winkler, are much the same as those given by the discoverers; but the determinations of the atomic weight differ considerably. Reich and Richter gave the atomic weight as 74·14 $(O=16)$; but Winkler's experiments lead to the number 35·918 $(O=8)$. Further researches on this metal, which has hitherto been only obtained in very small quantities, will, no doubt, clear up these discrepancies.

A paper of considerable importance was contributed to the Literary and Philosophical Society of Manchester, by Dr. F. C. Calvert and Mr. Johnson, and will be found in the 'Chemical News,' vol xi. p. 171. It relates to the action of sea-water on certain metals and alloys, and therefore will interest all concerned with shipping. We may pass over the laboratory experiments, and quote only the results of those made by immersing plates of the metals, 40 centimetres square, in the sea. The plates were left suspended in the water by a flax rope for a month. At the end of this time it was found that the following amounts of the metals had been dissolved :—

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* 'Journal für prakt. Chemie,' 1865.

† 'Chem. Central Blatt,' No. 17, 1865.

‡ 'Journal für prakt. Chemie,' No. 1, 1865.

	Grammes.
Steel	105·31
Iron	99·30
Copper	29·72
Zinc	34·34
Galvanized Iron	14·42

The results obtained with brasses, and Muntz's metal, show that these are much less acted on than pure metals, and there can be no doubt, the authors say, that shipowners derive great benefit from employing them. The great loss in the case of iron shows the necessity for a good protective coating for vessels made of that material.

Another paper of much technical interest was presented to the above-named Society by Messrs. Caro and Dancer. It was "On the Injurious Action of Alkalies on Cotton Fibre." A paper on the same subject, and evidently based upon a study of the same material, was read before the Chemical Society, by Dr. F. C. Calvert, and will be found in our account of the Proceedings, given below. It will be sufficient to say here that the writers are in accord as to the injurious action of alkalies on cotton, and manufacturers will, no doubt, discontinue the use ofsilicate of soda as a dressing.

Proceedings of the Chemical Society.

In the course of the last three months several papers of considerable practical interest have been communicated to the Society. The first of these was by Dr. F. C. Calvert, "On the Action of Silicate and Carbonate of Soda on Cotton Fibre," in which it was shown that cotton fabrics, impregnated with the silicate, became in the course of time perfectly rotten. Two explanations of the action were suggested. 1. The silicate decomposed by the carbonic acid of the atmosphere deposited silicate in the cotton-cells, distending and rending the cells, and so weakening the strength of the fibre, while the carbonated alkali, which has also an injurious influence on cotton, remained in contact. Secondly, it was suggested by Mr. W. Crum, that cotton fibre itself might have the power of fixing silica without the intervention of carbonic acid, and thus a caustic alkali would be liberated on the cotton.

Mr. Abel, from the results of experiments he had made upon canvas, believed that the cause of the rottenness was mechanical, and not chemical, since fabrics impregnated with a neutral salt, like sulphate of magnesia, became weakened, no doubt by the deposition of solid matter within the fibre, and the distension caused by crystallization—an opinion which was supported by Dr. Frankland, who quoted the familiar fact that the strength of cotton and linen is impaired by the action of frost.

At the same meeting Dr. Calvert showed some Crystallized Hydrate of Phenic Alcohol, or Monohydrated Carbolic Acid, and gave some reasons for preferring to regard the monohydrated oxide of phenyl as an alcohol, and not as an acid. The compounds which this body forms with alkalies are of a very indefinite character. It may be distilled without loss from an alkaline solution, and although it absorbs ammonia with avidity, it parts with it again when heat is applied. When, however, the ammoniacal compound or mixture is heated under pressure, aniline and water are formed. The so-called acid and the hydrate here spoken of both dissolved oxide of lead, and seem to form a definite compound $C_{12} H_6 O_2 + 2 P_b O$.

A paper, by Mr. Church, on some Cornish minerals, communicated the same evening, will be found noticed in its proper place.

A note by Mr. C. L. Bloxam, on the action of Chlorine upon arsenious acid made known the curious fact that in the reaction of these two bodies at a moderate heat, one portion of the arsenious acid, becomes oxidized at the expense of another, and thus terchloride of arsenic and arsenic acid are formed. The latter combines with arsenious acid to form a transparent glass, having the composition $2 As.O_2, As.O_5$.

At another meeting Mr. Bloxam read a paper "On the action of Hydrosulphate of Ammonia on freshly-precipitated Sulphide of Copper," by which it seems that a double compound of sulphide of copper and sulphide of ammonium is formed. It is a very unstable salt, which by great care can be obtained in vermilion-red crystals, very like those of chromic acid.

At the same meeting the same gentleman read some interesting and valuable notes on qualitative analysis. The first related to the reduction of binoxide of tin by cyanide of potassium. Sulphate of potash is often found as an impurity in commercial cynanide of potassium, and when binoxide of tin is fused with such a mixture sulphides of potassium and tin are produced, which combine together and dissolve when the fused mass is treated with water, thus causing a considerable loss of tin. In some cases both stannic and stannous sulphides are formed, and when commercial cyanide is an anaylsis both of these should be looked for; the latter will be left as a black powder when the fused mass is dissolved in water, and the former will be separated from the solution on the addition of hydrochloric acid.

Another note related to the detection of Zinc. Mr. Bloxam recommends that the supposed sulphide of zinc precipitate should be dissolved off the filter with hot dilute nitric acid, and the solution mixed with a very minute quantity of nitrate of cobalt. The whole should then be precipitated with carbonate of soda, the product collected in a filter, washed, dried, and afterwards incinerated on platinum foil, by which the green compound confirmatory of the presence of zinc is obtained. If the green colour should not be apparent at first, it will become visible when the residue is moistened and crushed. In this way the Professor said that $\frac{1}{10000}$th part of zinc in solution might be identified.

When testing for magnesia in the filtrate, from the ammonia and sulphide of ammonium precipitates with phosphate of soda, a flocculent precipitate sometimes makes its appearance at once, and obscures the magnesian reaction. This precipitate Professor Bloxam has found to be phosphate of alumina, formed in consequence of the slight solubility of alumina in ammonia, and in sulphide of ammonium.

Lastly, the same author read a note showing that in minute and exact analyses the mineral constituents of filter paper must be taken into account. A careful analysis of the ash of such paper has shown it to consist chiefly of clay and carbonates of lime and magnesia, with ferric oxide; but besides these, sulphates of potash, soda and lime, with traces of phosphoric acid and oxides of cobalt and lead, were present.

In an interesting communication "On the Periodides of some Organic Bases," Mr. Tilden made known the existence of several new compounds having a constitution like that of the iodo-sulphate of quinine, and possessed of similar optical properties. For a full account of these bodies we must refer the reader to the 'Journal of the Chemical Society' for April.

A paper, read by Dr. J. H. Gladstone, "On the Specific Refractive Energies of the Elements and their Compounds," belongs to Physics rather than Chemistry, and will be noticed in another place.

The last paper we can notice was by Dr. Miller, "On some Points in the Analysis of Potable Waters." The greater part of this valuable paper was devoted to an account of the method pursued by the author in the determination of organic matters. It is well known that the greatest discrepancies sometimes occur in the statements of different chemists regarding the same water, and Dr. Miller described the precautions necessary to ensure exact results by the incineration process. He also described at some length the mode of determining the amount of oxidizable organic matter by means of a standard solution of permanganate of potash. This reagent, although it does not discriminate between different kinds of organic matter, still affords tolerably precise indications of the quantity present, and moreover is most readily acted on by those matters which are most objectionable in water. In reply to the objection that the presence of nitrites might affect the test, Dr. Miller said that it was easy to discriminate between these and actual organic matters, since the former decolorized the solution instantly, and the action of the latter was progressive; so that the pink solution might be added until the water became permanently coloured, and the subsequent slow decolorization might be set down to organic matters. As a positive test for the presence of nitrites, the author gave that proposed by Dr. Price, *viz.* a solution of iodine of potassium and starch with a drop of dilute sulphuric acid, but we may state that this test is open to a fallacy, since iodine is set free when chlorides and nitrates are present, and nitrites altogether absent. For the determination of nitrates, Dr. Miller recommended the process of Dr. Pugh, which is no doubt well known to our readers. In the discussion which followed, the advisability of adopting a uniform method of stating the results of an analysis was strongly dwelt upon by several chemists, and it is to be hoped that the publication of this valuable paper will contribute to that end. It was announced for publication in a forthcoming number of the 'Journal of the Chemical Society,' and we shall probably have occasion to refer to it again.

V. ENTOMOLOGY.

(*Including the Proceedings of the Entomological Society.*)

A most important contribution to Natural History as well as to Entomology has just been published by the Linnean Society. It is an article by Mr. A. R. Wallace, "On the Phenomena of Variation and Geographical Distribution, as illustrated by the Papilionidæ of the Malayan Region." It is of course written from the Darwinian point of view, but is especially valuable as embodying the observations made by the author on that particular family of butterflies during his long and arduous explorations in the Eastern Isles. We can only give a brief abstract of a paper which occupies nearly 71 quarto pages, and regret that our space will not permit a more detailed analysis.

The greater sensibility of the diurnal Lepidoptera to modifying causes is well known, and therefore in no other families of insects is there so much difficulty in determining what are species and what only varieties. The definition of Pritchard, that "separate origin and distinctness of race, evinced by a constant transmission of some characteristic peculiarity of organization," constitutes a species, is adopted by Mr. Wallace, so far as when the difference is not confined to a *single* peculiarity, and leaving out the question of origin. To this it may be objected that practically it will be all but impossible to tell what peculiarities are constant, or transmitted from generation to generation, in the great mass of specimens that may come under the eye of the Entomologist. Besides, 1st, *simple variability*, Mr. Wallace distinguishes—2nd, *polymorphism* (or *dimorphism*); 3rd, *local forms;* 4th, *coexisting varieties;* 5th, *races* or *subspecies;* and 6th, *true species.* By *simple variability* the author includes "all these cases in which the specific form is to some extent unstable." Closely allied to some of these variable species are others, which, though only slightly differing from them, are constant and confined to limited areas. These local forms are treated by Mr. Wallace as distinct species. *Polymorphism* or *dimorphism* implies the coexistence of two or more distinct forms in the same locality, "occasionally produced from common parents," the union of these distinct forms not producing intermediate varieties, but reproducing the parent forms unchanged. Several curious cases (generally confined to the female sex) are given, but the phenomena will be more clearly understood by the following illustration:—Suppose "a blue-eyed, flaxen-haired Saxon man had two wives, one a black-haired, red-skinned Indian squaw, the other a woolly-headed, sooty-skinned negress,—and that instead of the children being mulattoes of brown or dusky tints, mingling the separate characteristics of their parents in varying degrees, all the boys should be pure Saxon boys like their father, while the girls should altogether resemble their mothers. This would be thought a sufficiently wonderful fact; yet the phenomena here brought forward as existing in the insect world are still more extraordinary; for each mother is capable not only of producing male offspring like the father, and female like herself, but also of producing other females exactly like her fellow-wife, and altogether differing from herself." *Local forms* or *varieties* are, it appears to us, scarcely distinguishable from races or subspecies, except that the differences are slighter, but surely this is not sufficient to constitute a distinct phenomenon. The *coexisting variety* "is a somewhat doubtful case." It is "when a permanent and hereditary form exists in company with the parent or typical form, without presenting those intermediate gradations which would constitute it a case of simple variability." This can only be distinguished from dimorphism by direct evidence of the two forms breeding separately. *Races* or *subspecies :* "these are local forms completely fixed and isolated," and, as we have already said, are treated by Mr. Wallace as species. As, however, it is admitted that "these may and probably have been derived from a common stock," it seems more convenient to use the word *subspecies* than to obliterate the distinction between an ordinary well-marked form and what is avowedly often only a slight though permanent modification, by calling both *species*, albeit it may be desirable in some cases that they should have a specific name.

Species.—Here Mr. Wallace, notwithstanding the Pritchard definition, confesses that "we have no means whatever of distinguishing so-called 'true species' from local forms and varieties; but the experience of any one who has studied any large family of insects will confirm this assertion that in many instances 'not single species but whole groups' have, from the accumulation of materials, been proved to have 'no definite specific limits.'"

This is, however, scarcely sufficient to prove the origin of species by variation and selection, though it shows that the permanence of species is not to be depended on within any limits than can at present be defined.

So far as the phenomena of variation among the Papilionidæ are influenced by locality, Mr. Wallace has come to the following conclusions:—1, the species of the Indian Region (Sumatra, Java, and Borneo) are almost invariably smaller than the allied species inhabiting Celebes and the Moluccas; 2, the species of New Guinea and Australia are also, although in a less degree, smaller than the nearest species or varieties of the Moluccas; 3, in the Moluccas themselves the species of Amboyna are the largest; 4, the species of Celebes equal or even surpass in size those of Amboyna; 5, the species and varieties of Celebes possess a striking character in the form of the anterior wings, different from that of the allied species and varieties of all the surrounding islands; 6, tailed species in India or the Indian Region become tailless as they spread eastward through the archipelago.

We are unable to enter into any of the numerous details given in illustration, but they furnish in the author's opinion "a strong corroborative testimony in favour of the doctrine of the origin of species by successive small variations." As to the causes which have led one group of butterflies to imitate another, the author agrees with Mr. Bates, that the object of mimicry "possesses some means of defence (probably in a peculiar odour or taste), which saves it from attack," and the imitating groups "thus gain an advantage in a freedom from persecution similar to that enjoyed by those they resemble." It would certainly have been more satisfactory if we had been furnished with any evidence of these persecutions which are supposed to have led to such important results.* Notes are given of 123 species of Papilionidæ belonging to the Malayan Region, ranged under the genera *Ornithoptera*, 16 species; *Papilio*, 103 species; and *Leptocercus*, 4 species; but for these, and the remarks on their arrangement and geographical distribution, we must refer to the paper itself, which is illustrated by seven coloured plates. Unfortunately, however, the upper surface of the wing on one side and the lower on the other, are represented in each figure, and this gives an awkward appearance to the whole, and deprives them of all æsthetic value.

The difficulty as to what are species and what only varieties, receives an illustration from Mr. F. Smith's paper "On the Species and Varieties of the Honey-Bees belonging to the Genus Apis." ('Ann. and Mag. Nat. Hist.,' vol. xv. p. 372.) Mr. Smith had described twenty species; Dr. Gerstaecker, with the exception of two species, apparently accidentally overlooked, reduces these to four. In the paper above quoted, its author now limits them to eight. In the same volume of the 'Annals' (p. 182), is a translation of Professor Schiodte's paper "On the Classification of Cerambyces, with particular regard to the Danish Fauna." The author is patriotic enough to adopt the ordinal names of his countryman Fabricius, and he even finds it "necessary to return to that point to which Fabricius had carried our systematic knowledge, and to continue where he had left off." Many of his suggestions have been anticipated long ago, but the Professor is apparently not aware of Dr. Leconte's contributions to the American Scientific Journals, or of the still later works of M. James Thomson and others. A long account of the Chigoe (*Rhyncoprion*, or more correctly *Sarcopsylla penetrans*) is furnished by Karsten to the 'Bulletin de la Société de Naturalistes de Moscou.' It is only the fecundated females which are parasitic. They establish themselves under the skin, generally under the toe-tails, and soon attain an enormous size; when all the eggs are developed and deposited, the empty and shrivelled body is supposed to be thrown out, but whether the larvæ are developed in the ovary, or from the eggs after deposition, has not yet been ascertained.

A singular instance of parasitism has been recorded in the 'Entomologist's Monthly Magazine' (vol. i. p. 281). One of the white butterflies (*Pieris rapæ*), on emerging from the pupa, was found to have two little yellow cocoons of *Microgaster glomeratus*, containing pupæ, rolled up in the wings. The butterfly lived for some days, and excepting that the wings never attained their full size, was otherwise perfect. The ichneumon flies, however, it appears, were dead. The editor's explanation is this:—"It is well known that, as a rule, the female *Microgaster* deposits a large number of eggs in one larva, and it is probable that a larva, once attacked, is freed from further molestation; the parasites knowing instinctively that the larva could only nourish a certain quantity to maturity. Possibly, therefore, the *Microgaster* attacking the above larva was disturbed after laying but very few eggs, and the produce of these was not sufficient to destroy the *Pieris* larva. If the parasites had not escaped previous to the transformation of their victim into the pupa state, they would naturally be unable to force their way through the hard pupa skin; and, as it seems, would form their cocoons inside, and be dragged out by the struggles of the butterfly to escape."

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* At a meeting of the Entomological Society (May 2nd, 1864), when this subject was discussed, Mr. Bates said it was not an uncommon thing in this country to see the Pontiæ pursued by birds. Mr. Wallace admitted that he had not seen butterflies pursued to any great extent. Major Cox had seen forty or fifty individuals of a moth (*Brephos notha*) destroyed by tom-tits in a single morning. Dragon-flies were also suggested as being destructive of butterflies.

M. l'Abbé de Marseul has given descriptions of the *Histeridæ* collected by Mr. Wallace, in 'L'Abeille.' There are 101 species, of which 54 are new. Dr. A. Dohrn continues his descriptions of New Dermaptera in the 'Stettiner Entomologische Zeitung.' The fourth 'trimestre' of the French Entomological Society has not yet been received.

ENTOMOLOGICAL SOCIETY.

At the March meeting of the Society, Mr. M'Lachlan read a paper, entitled, "Trichoptera Britannica: a Monograph of the British species of Caddis-flies." 124 species are described, belonging to forty-three genera. Mr. Pascoe read a paper "On Generic Names having the same Sound," in which he strongly deprecated the practice recently adopted by some Continental naturalists, of changing generic names whenever they happened to differ but slightly from previous names. At the same meeting it was announced that the Council of the Society had determined to offer two prizes, of five guineas each, to the authors of the two best Essays or Memoirs on the anatomy, economy, or habits of any insect or group of insects which is in any way serviceable or obnoxious to mankind.

At the April meeting, Mr. Bates read a paper "On Agra," a genus of Carabidæ. The species are arboreal in their habits, and possess crepitating powers, the explosion not being audible, but capable of being distinctly felt, and leaving a stain upon the fingers. There were 140 species described, mostly by the Baron de Chaudoir; Mr. Bates now adds sixteen new species taken by himself in the Amazon region. Some very peculiar kinds of galls (if some of them were really the productions of insects) collected by Mr. Lowne in Syria, were exhibited by Mr. W. Wilson Saunders. An extract from a letter was read by Mr. Pascoe, in which the writer mentioned that the sounds emitted by a species of *Bolboceras* found burrowing in the hard roads at Gawler, South Australia, were caused by rubbing the tarsi against the coxæ. Some doubts were expressed as to the accuracy of the writer's observations.

At the meeting in May, the Reverend Hamlet Clark read "Descriptions of new Phytophaga from West Australia." Among them was a very abnormal form belonging to the family Eumolpidæ; it is a leaping insect, but the saltatorial power is given not by the posterior legs, as is otherwise invariably the case, but by the intermediate, the femora of which are thick, robust, and tolerably elongate, with curved tibiæ. It was proposed to be described under the name of *Thaumastomerus viridis*. Mr. Bates read a paper "On a New Species of Agra, from the Collection of Mr. W. Wilson Saunders;" and Mr. F. Smith read "Descriptions of some Species of Hymenopterous Insects belonging to the families Thynnidæ, Masaridæ, and Apidæ."

In the last part of the Journal, at page 285, it was stated that the number of members of this Society was but ninety-seven. This, however, comprised those only who had paid their subscriptions for the year, not those who had compounded, or who were in arrears. The real number was, at the time, about 140.

VI. GEOGRAPHY.

(*Including the Proceedings of the Royal Geographical Society.*)

At one of the latest of the meetings of the Royal Geographical Society, an eminent authority on geographical, as well as other scientific matters, spoke with somewhat of nervous excitement, of what he considered the want of attention paid by the scientific men of England to a foreigner, then lying on a sick bed: he spoke of Lieutenant Maury. Within a few days after leaving this learned Society for the sick-bed of his friend, Admiral Fitzroy himself lay stretched upon the bed of death, stricken by a hand no longer guided by the light of that reason which has founded a new science amongst us; but moved by frenzy, of which the excitability of the former evening had been but the prelude, the flicker as it were of the summer lightning before the storm began. The over-taxed brain broke down amidst its work. That work has become a household word among us. In looking for Admiral Fitzroy's forecasts of the weather, we are apt to forget the earlier tributes which he paid to science. In two voyages in the 'Beagle,' in the latter of which he was accompanied by Mr. Darwin, he performed important work in surveying the southern hemisphere, and by describing what he had surveyed, he made permanent his discoveries. His researches on meteorology have placed that subject on the footing of a science, and whatever discoveries may hereafter be made in this direction, will have to be attributed to the excellent order and arrangement that he has introduced amongst the mass of already well-known facts, and to his patient abstinence from prejudging where the temptation must have been very great. Besides this, Admiral Fitzroy was at one time a member of Parliament, and afterwards Governor of New Zealand.

A younger and a less known man, Henry Christy, had just been recommended by the Council of the Royal Society to be honoured with the mystic letters F.R.S. after his name, but death forbad the investiture. Originally in business, he had devoted his later years to travel and scientific investigations, chiefly in reference to the early history of mankind as told to us in customs and in antiquities of savage nations. He explored that extremely interesting and little known country, Mexico, in company with Mr. Edward Tylor, the author of 'Anahuac,' a work of great research, and still later of a very thoughtful, carefully collected, and judicious book, entitled 'Researches into the Early History of Mankind.' These two works of his friend and companion indicate the line of research of Henry Christy, and in him the scientific world has to regret a patient collector and a learned thinker. Mr. Christy was no mere musty antiquarian; but his sympathy and his charity were warmly extended to many in their need—to the Irish during the famine, to the Danes during the war.

After our losses, let us reckon our prospective gains. Next in importance to the exploration of the neighbourhood of the North Pole, which we defer noticing until we come to the proceedings of the Geographical Society, ranks the proposal for the exploration of Palestine. This is certainly an association of things new and old, which ought to keep us in mind of our own ignorance, and make us a little humble as to our scientific acquirements. That the country most interesting to us, not only on religious grounds, but even on a mere historical basis,—for the history of the Jews is the oldest, and of old histories the best known of all,—that this land should be so little known to us that we cannot determine very many important localities; that we should know nothing, comparatively speaking, of its geological formation; and that the remains of its ancient races once hidden beneath the soil, have never been disturbed by the spade of the explorer, is extraordinary, to say the least of it, and if we can afford, for a time, to forget the disgrace which this entails upon us, it may be a most fortunate circumstance, since all that may be henceforth brought to light will be most carefully preserved, and accurate note will be taken of the position and accompaniments of each separate discovery. The survey of Jerusalem and of the level of the Dead Sea by the sappers under Captain Wilson, R.E., has suggested to a body of clergymen and laymen the propriety of forming a fund, similar to the Assyrian Exploration Fund, for extending this kind of survey and increasing its usefulness. There is much in the geology of the Holy Land, especially in the condition of the valley of the Jordan and the Dead Sea, that will excite the curiosity of the lovers of this science. The architecture of this country, perhaps, affords a wider scope than any in existence, since we have Jewish, Roman, Crusading, and Moslem modifications, all embraced within a small area, though extending over a vast period of time. Probably a not unimportant light may be thrown upon the origin of our own so-called Norman style, as originating from the influence of the Crusading and Moslem buildings upon one another. Again, the Holy sites have ever afforded a bone of contention for sects and topographers to wrangle over. Many of these must be, once for all, determined by a really careful survey, and the pretensions of such men as Dr. Priotti and Mr. James Fergusson will be estimated at their full value. The botany, zoology, and meteorology of this country all deserve attention, and though they have received some light from the labours of Tristram and others, and though a survey cannot be expected to effect much in the short time which can be allotted to it, nevertheless its researches may afford a nucleus about which many now scattered facts may accumulate and add much to our very scanty information. The matter resolves itself into one of money. If the means are forthcoming much may be done, and that they will be so forthcoming the success of the Assyrian Excavation Fund gives good promise. It is to be hoped that if this expedition is sent forth upon a really substantial basis, its work will not be confined within too narrow geographical limits. The country east of the Sea of Tiberias, Jerash, and the neighbouring cities, as well as the more southerly districts of Moab, &c., are practically unknown, whilst Laborde's work on Arabia Petræa leaves much to be desired in that locality.

The two great volcanoes of Europe, Ætna and Vesuvius, have been for some time exhibiting signs of uneasiness. Whilst an eruption has actually taken place in the former, the latter has been reported to have its crater filled with seething lava, and to be capped by a suspicious fire and smoke. Earthquakes have been felt in Malta, Corfu, and other adjacent lands. But Ætna has afforded a magnificent spectacle. From seven mouths the molten mass of lava has been belched forth over hill and dale, and the whole neighbourhood has been terrified by the incessant noise, the lurid fires, and the destruction of cultivated land. Some of the sounds from the upper craters have been compared to the rapid blows of a smith upon his forge, and if the ancients ever heard such sounds, it is not to be wondered at that they invented the story of the Cyclops to account for these marvels. The French Government, who are never behindhand in any scientific investigation, have sent out a Commission, of which M. Fouqué is one, to determine the nature of the eruption. According to his report, the deep valleys and the sub-divisions of the streams have delayed the progress of the lava, so that no very extensive district has been destroyed. The vapours arising from the eruption have been divided by him into four classes: (1) the dry, containing salt, brooding over the incandescent lava; (2) the acid, with much water, in those places where the heat was above 400°; (3) the alkaline, where the thermometer stood between 100° and 400°; and (4) the carbonic, amid the lower temperatures. All these have been observed, classified, and tested. It is rather remarkable that but little sulphur has been perceptible; chlorine being on the other hand very common. Several photographs have been taken by M. Berthier, who accompanied the expedition for that purpose.

The interior of South America is about to be explored by Mr. Edward Bartlett, who intends to continue the researches in Natural History begun by Mr. Bates. The Brazilian authorities have received this gentleman with great civility, and have remitted in his case many of the vexations, as at the best of times they always will be, of the Custom-house. He reports that three lines of steamers now run up the river Amazons, dividing amongst themselves a distance of about 2,600 miles, beyond which again for nearly 500 miles navigation is open to large vessels.

We are again looking forward to an Atlantic Telegraph, executed with more care and forethought than the previous unhappy failure. At the same time that this cable is about to be laid, a project for uniting the western coast of America with Asia is on foot; and, it is said, begun. From San Francisco the wires are to travel northward along the coast of British Columbia, traversing forest, fell, and river, until they have crossed the almost unknown districts of Russian America. Leaving Cape Prince of Wales, they will span Behring's Straits, where it is only thirty-six miles wide, and will again descend the eastern coast of Asia to the river Amoor. It is hoped to reach this point as soon as the telegraph from St. Petersburgh, and then we shall be in almost direct communication with British Columbia, and even California.

Central Africa, that exercising ground of incipient geographers, contributes but little to our chronicle this quarter. M. Eugène Jacques Marie de Pruyssenaeve died at Harab-al-dunia, near Khartum, on the 15th of December last, in his thirty-ninth year. Mr. Gerard Rolphs has started from Tripoli towards Timbuctoo, aided by supplies from Germany and our own Geographical Society. Dr. Mann, of Maritzburg, in Natal, has published the abstracts of six years' meteorological observations at the Observatory on that spot; according to these observations, the mean temperature nearly coincides with that of Adelaide in South Australia, a district some way further south, but having a hot and probably arid continent of land to the direct north of it, whereas Natal has land to the west only with a tendency of wind from the east. The amount of rain is greater than in London, though it falls upon fewer days in the year. Lightning was visible on 129 days in the year. The range of the thermometer is not extreme, being from 97·1° to 29°, or only 68·1° Fahrenheit. Of the 38·3 inches of rain that fell in 1864, the wettest year observed, 36·2 inches fell during the tropical showers of six wet months, leaving only 2·1 inches for the remainder of the year.

The captives in Abyssinia still remain in prison, and there seems little probability that either they or Captain Cameron, the British Consul, will be liberated except by death.

Towards the end of February last, the colony of Victoria was visited by a day of frightful heat and hot wind. The thermometer in many places stood very nearly at 100° in the shade; and in Sandhurst it even reached 105°. From the accounts we have received, we are unable to state whether the heat was the cause or the effect of enormous bush fires. The heat was accompanied by hot blasts of dense air, laden with smoke and dust, which almost prostrated the whole population. Fortunately, towards 5 o'clock P.M., the wind veered round to a mild south breeze, with slight rain; nevertheless the sky remained thick with smoke, and towards night it reflected with appalling grandeur the lurid glare of the distant bush fires. The destruction of crops and produce by the fires has been enormous, and can scarcely as yet be estimated.

PROCEEDINGS OF THE ROYAL GEOGRAPHICAL SOCIETY.

An improvement in maps, being stereoscopic views taken from models of a country, is a subject worthy of the consideration of a Geographical Society, and as such was brought forward by Messrs. F. Galton and R. Cameron Galton. A model of a district, divided into squares and painted white, is photographed, and the resulting slide can be carried and used as easily as ordinary stereoscopic slides, whilst the information conveyed to the eye is of a different character and far more extensive, since the comparative height of all elevations can be seen at a glance. The mode of attaching names forms a source of difficulty, but this can be avoided by carrying another map. In any case it is a convenient mode of carrying what has all the advantages of a model with one on a journey.

"The Desiccation of Inner Southern Africa" formed the topic of a paper by Mr. James Fox Wilson. The aridity of the country has increased much within the memory of man, and a very great decrease of moisture is observable within certainly modern times. The *origin* of this parching up of a whole country was the only subject of discussion; of the fact there is no doubt. Dr. Livingstone considered that volcanic and geological changes were the principal causes, whilst Mr. Wilson is inclined to attribute a considerable portion of it to the felling of timber and other works of human influence. The matter is of some importance, inasmuch as in the one case we cannot help ourselves; but in the other, the interference of Government with the rapid clearing of districts might effect much towards modifying the evil, which is undoubted. The experience of Northern Africa might perhaps be useful in the South.

At the ninth and tenth meetings, a topic was again brought forward which had already been discussed, but which, nevertheless, still excites much interest, and is not likely to fall into oblivion until some practical result is arrived at. Since Sherard Osborn's first paper on the subject, an expedition to the North Pole has been urgently demanded, not only by geographers, but by men of science generally, as likely to throw light upon many highly interesting problems of climate, atmosphere, magnetic electricity, ethnology, and perhaps of archæology. The first document during this quarter on the subject, was a second letter from Dr. Petermann, of Berlin, who formerly accompanied an expedition to the Antarctic regions. This gave rise to considerable discussion. It was followed by papers "On the Climate of the North Pole," by Mr. W. E. Hickson; and "On the best Route for North Polar Exploration," by Mr. C. R. Markham. Dr. Petermann's object was to induce English geographers to adopt his plan of exploration by way of Spitzbergen, and the seas to the east of that island, in preference to the route by way of Smith's Sound and the west of Greenland. Steam vessels have never been tried in this direction, and the Doctor expresses confidence that a well-managed screw-steamer might easily penetrate the band of pack ice by which, he contends, the open sea at the Pole is surrounded.

The question, of course, turns principally on the probability of there being ice or land on the one hand, or water on the other, in the immediate vicinity of the Pole, a question which will probably be specially discussed in this Journal, and which we will, therefore, not touch upon here.

Spitzbergen affords many conveniences as a place to winter in, both on account of its accessibility and also because of the supplies of game that might be procured there. The route in this direction, too, is decidedly shorter than by Smith's Sound; but the main difficulty that can be foreseen is an impenetrable barrier of ice, after the pack ice and the open sea beyond it have been passed, a difficulty which is known to exist at the Antarctic Pole. The comparative merits of the two routes have been well discussed before the Society, and now the results have been placed before the Government, it only remains to await their decision.

Colonel Lewis Pelly, whose paper, "On the Islands of Kishm and Ormuz," we noticed in a former number, in a despatch to the Bombay Government, by whom it was communicated to the Society, stated that he was about to visit the capital of the Wahibite kingdom, in company with Lieutenant Dawes and Dr. Colvill. Colonel Pelly, in 1861, rode from Teheran to Calcutta in his uniform as a British officer, and the accomplishment of this difficult task was a fair earnest that he would fulfil his intention on the present occasion. The telegraphic announcement of his arrival at Bushire on his return has since been received.

A paper by Mr. Laurence Oliphant, "On the Bayanos river, Isthmus of Panama," draws attention to a spot where the two great oceans approach nearer to each other than elsewhere, but which spot, nevertheless, has been overlooked by surveyors. The distance to be traversed is only fifteen miles, but this has never been accomplished by a white man. The Indians have, as yet, stopped two travellers—Messrs. Wheelwright and Evan Hopkins—but they are said to drag their own canoes across from Chepo, the place visited by Mr. Oliphant, to the Mandingar river. The Columbian Government are endeavouring to make a road over the pass referred to in this paper.

The search for the seeds of the Pitayo cinchona plant for the Government of India, led Mr. Robert Cross from Chimborazo to Bagota, through the country of the Central Andes. The trees from which seeds could be obtained are fast dying out, but a good supply was obtained, which, it is hoped, will multiply in another part of the world. In passing the bleak plateau of Guanacas, Mr. Cross's mules had a narrow escape from perishing by cold, and the road was strewed with skeletons of men and beasts.

"The Specific Gravity, Temperature, and Currents of the Seas passed through between England and India," furnished Captain Toynbee with the materials of an interesting paper. The equatorial rains perceptibly affect the specific gravity of the water both of the Atlantic and also the Indian Oceans. The temperature showed the direction of the cold current which sweeps northward along the west coast of Africa in July, and which curves sharply to the westward after crossing the line, in about 17° W. longitude. That this current comes from a southern origin is shown by the fact that it is at a higher temperature in March after an Antarctic summer. The southern ocean, too, sends icebergs into Table Bay, whilst the sea, only a short distance to the south-east, is at a much higher temperature.

"The Rovuma river, East Africa," described by Dr. Kirk, is interesting as being the point from which Dr. Livingstone intends to start on a new expedition into the interior. This stream is accessible to small vessels, in consequence of having no bar, and it leads inland just opposite to Lake Nyassa, from which the rapids that prohibit further navigation are distant not more than 100 miles. Dr. Livingstone intends to explore the whole of this lake, and, if possible, that of Tanganyika, and in this way to determine their connection and the line of the watershed of this region.

Dr. Gunst has visited several unexplored parts of North Madagascar, and found in the mountains tin ore, gold, traces of copper, and abundance of copal trees. He experienced some rough treatment from robbers, but was released by means of a vessel sent to his relief by the French Commander of St. Mary.

On the 22nd of May, the Anniversary Meeting of the Society was held at Burlington House, when the President delivered an address, and presented the medals, that of the founder to Captain Montgomery, R.E., for his trigonometrical survey from the plains of the Punjab to the Karakoram range; that of the patron to Mr. Samuel Baker, for his explorations of the interior of Africa entirely at his own cost.

Sir Roderick Murchison gave slight sketches of the lives of deceased Fellows,—the Duke of Northumberland, Captain Speke, and Admiral Fitzroy. He then touched upon the progress of geographical science. Australia has been explored over two-thirds of its surface, Cape York settled, Van Diemen's Gulf and the Northern Victoria river will probably soon be in the same condition; the coast has been surveyed, and a safe passage secured from Torres Straits to Queensland. It requires but little further exertion to secure constant communication with these colonies by way of the Singapore and the Eastern Islands. In our own possessions in America, especially in the great territory of the Hudson's Bay Company, much work remains to be done, and that such work is not altogether uninteresting is shown by the journey of a young nobleman and his companion across the Rocky Mountains to California. Central America has been again brought before us by Mr. Oliphant (to whose papers we have referred above). In Asia, the vast unvisited empire of China promises to afford means of testing the accuracy of our only predecessors, Marco Polo, Huc, and Gabet. The Korea, once under Japanese rule, and the extensive empire of Japan itself, also are likely to supply material for research for some considerable time to come. Dr. Livingstone's book, which is shortly to appear, will show that much is still unexplored in the unknown regions of Southern Africa, even if Mr. Samuel Baker, who was last heard of at Ungoro, has been enabled to accomplish all that he wished and attempted, and notwithstanding the labours undergone by Mr. Charles Livingstone, Dr. Kirk, and the late young Thornton, each in his special line. In conclusion, the President informed the Society that he had communicated with the Grand Imperial Geographical Society of St. Petersburg on the subject of an expedition to the North Pole, and that, emboldened by their support, he had appealed to the First Lord of the Admiralty and to Her Majesty's Government, enumerating the advantages to science to be derived from a North Polar expedition, and transmitting copies of various supporting documents from other Societies.

VII. GEOLOGY AND PALÆONTOLOGY.

(*Including the Proceedings of the Geological Society.*)

Sciences bear to one another much the same relation as kingdoms and empires; and the connections of the latter by trade resemble, not very remotely, the aids which sciences give to each other. Thus geology has been assisted by several sciences, and has helped them in return; but it is generally considered that her "imports" have greatly exceeded her "exports." We are therefore glad to be able to adduce an important item towards producing a balance.

Geography and geology are naturally closely allied; to the one belongs the surface of the earth, to the other its substance. Of late years physical geography has been considered a separate science, forming the border-country between the two; and though it belongs more strictly to geography, it has necessarily been extensively invaded by geologists.

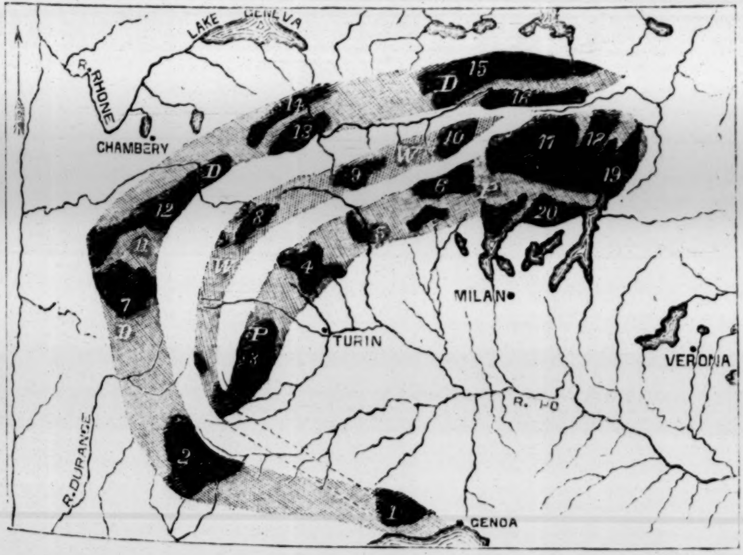
The physical features of mountains constitute an important subject of investigation to physical geographers, and the Alps have attracted their attention perhaps more than any other range. Until recently it was the custom to consider all great groups of mountains as forming "chains," but the irregularity of the Alpine so-called "chain" has long been a source of perplexity to its investigators. Geology has lately, however, suggested an explanation of this irregularity, and several Swiss geologists have come to the conclusion that the Alps do not form a "chain" of mountains at all; but that they consist of a number of central masses of crystalline rocks, flanked by valleys of slate, or other softer material. In other words, there is no great axis of upheaval; but the elevatory force was exerted at a number of points having no very evident linear connection, and separated by intervals of lower ground consisting of less crystalline rocks than the higher peaks

This theory has received its greatest development from M. Desor, in his work 'Der Gebirgsbau der Alpen,' just published. He describes thirty-six "central masses," the first twenty of which are included in the annexed sketch-map. They are distinguished as follows :—

Central Masses of the

1. Ligurian Alps.
2. Maritime Alps.
3. Cottian Alps.
4. Graian Alps.
5. Sesia.
6. Monte Rosa.
7. Pelvoux, or Oisans.
8. Vannoise.
9. Valais.
10. Simplon.
11. Les Rousses.
12. Belledonne, or the Western Alps.
13. Mont Blanc.
14. Aiguilles Rouges.
15. Finsteraarhorn.
16. St. Gothard.
17. Tessin.
18. Adula.
19. Sureta.
20. Four Lakes.
21. Bernina.
22. Monte Adamello.
23. Selvretta.
24. Stelvio.
25. Oetzthal.
26. Ortles.
26 bis. Trentaises.
27. Tauern.
28. Ankogel.
29. Drau.
30. Carnian Alps.
31. Styrian Alps, or Hochgolling.
32. Gurk.
33. Carinthian Alps.
34. Bacherwald.
35. Sömmering.

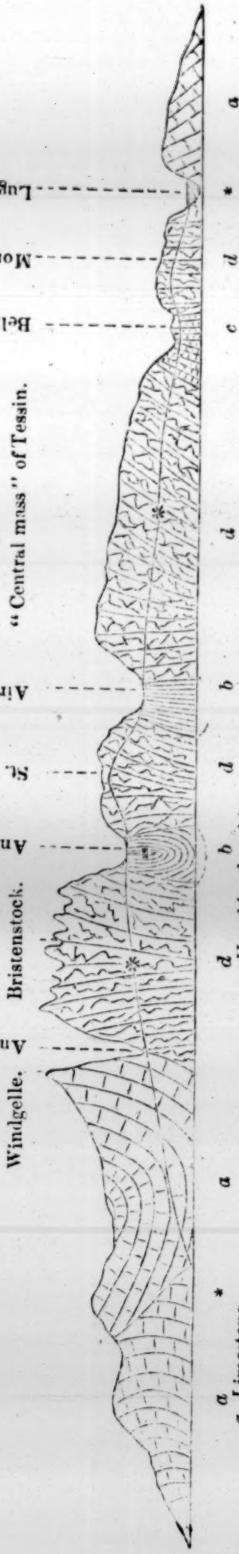
Fig. 1.—*Sketch-map of a Portion of the Alps, showing the relationship of some of the principal "Central masses."*



M. Desor also shows that although there is no proper Alpine "chain," the "central masses" have yet a certain relation to one another, and he refers those shown in the map to three "groups," namely, the Dauphiny group (marked D), the Valais group (marked W), and the Piedmont group (marked P).

The following section along the St. Gothard route further elucidates the relations of the central masses, and shows that although they are often close together, so that in a broad sense some geographers may consider them to form a chain, yet that the fact of their not

FIG. 2.—*Section across the St. Gothard Pass (after Desor).*



a. Limestone.
b. Metamorphic schist.
c. Hornblende-schist.
d. "Central masses" of Gneiss and Granite.
* St. Gothard route.

forming one continuous axis of upheaval, and their consisting of a series of independent masses of crystalline rocks, separated by low grounds formed of Triassic and more recent strata, show that the term "chain" is philosophically a misnomer, and that the Alps really consist of a group, or a number of groups, of more or less independent mountains.

But this is not the only question discussed in Professor Desor's work. The origin of lakes, the erratic and glacial phænomena of the Alps, and many other points of interest and importance in their physical geography and geology are investigated by him. We can only give a short *précis* of his views respecting the origin of the Swiss and Italian lakes.

The Alpine lakes he refers to two types, namely, the "orographical or mountain lakes," and the "excavated lakes." The former lie in the midst of mountains, and are one of the results of their elevation, while the latter are situated in the plain or on the borders of the mountains, and their basins have been excavated by *water.* The last conclusion, coming as it does from so eminent a Swiss geologist, is very important, especially as he considers also that the evidence is sufficient to prove that the lakes existed *before* the Glacial period. The Swiss lakes were for the most part "excavated by water," according to M. Desor, while the Italian lakes are situated in depressions between the mountains at right angles to their general direction. The Brianza-See belongs to yet another category, being a moraine-lake.

Another important contribution to Swiss geology has also reached us during the past quarter, namely, 'Geologische Beschreibung der

Nordoestlichen Gebirge von Graubünden,' by Professor G. Theobald. The author has good grounds for dilating, in his opening chapter, on the difficulty of geological surveying in this mountainous region, which is one of the most intricate and disturbed in Switzerland, and where the rocks are often masked by glaciers and fields of snow, while extraordinary contortions and even overturnings of the strata are so abundant as to become commonplace occurrences. Add to these difficulties that the rocks are often highly metamorphosed, so that different beds frequently look alike, while the same rock appears under a dozen different aspects, and that the fossils have generally been obliterated by the metamorphism, and we may then picture to ourselves the amount of patient and conscientious labour required of Professor Theobald during his survey of this district.

But this book, besides containing a complete geological description of the district to which it relates, includes a short essay on the physical features of the Alps, in which the author adopts the theory just explained, and describes in detail the central masses which he has examined. He observes that they consist of crystalline rocks, chiefly Gneiss, but sometimes Hornblende-schist and Mica-schist, while true granite is much less abundant than has hitherto been supposed. Around and between the central masses are zones of sedimentary strata, often metamorphosed into clay-slate, &c., the crystalline rocks having been thrust up from beneath them in anticlinal ridges, or more frequently in excessively contorted or reversed folds, not suddenly, nor by any grand convulsion, but slowly and silently. Professor Theobald truly remarks that the Alps cannot be understood geographically if their stratigraphical features be not taken into consideration.

Having thus indicated the chief features of this theory of the Alps, we must leave it to those particularly interested in the subject to read for themselves the descriptions of the different types of central-masses, and the numerous cases in which surface-form is shown to be dependent upon geological structure.

The last volume of the 'Bulletin de la Société Géologique de France,' contains an important paper by M. Levallois, entitled 'Les couches de jonction du Trias et du Lias dans la Lorraine et dans la Souabe,' &c. It may be considered the continuation of his paper on the 'Grès d'Hettange,' published in the previous volume. The author brings to the subject a larger share of philosophical coolness than French geologists usually possess, for he declares his belief that the boundary line of the Trias and Lias is destined to be the subject of eternal dispute.

The passage-beds, however, are shown by him to occur uninterruptedly and with a uniform constitution from the Ardennes to Morvan; they are composed chiefly of a sandstone which is the 'grès infra-liasique' of various authors, and which contains the fossils of the zone of *Avicula-contorta*. In the departments of the Meurthe and the Moselle and in Luxembourg they are constantly separated from the Hettange beds by an unfossiliferous band of red clay more than fifteen feet in thickness. He considers that the 'grès d'Hettange' is not the representative of the ‘grès *dit* infra-liasique,’ and that while the fossils of the former are altogether Liassic in character, those of the latter are almost entirely Triassic; and, moreover, he states that there is less analogy between these two faunas than between the fauna of the Hettange beds and that of the zone of *Gryphœa arcuata* above them. In view of the facts he enumerates and the inferences to which they have led him, M. Levallois suggests that the term ‘infra-liassic’ should be abandoned, as far as concerns the zone of *Avicula-contorta*, and that the term ‘supra-keuperian’ should be used in its stead.

The geological results of the voyage round the world of the Austrian frigate ‘Novara,’ are being published with praiseworthy rapidity and in a remarkably liberal style. The ‘First Part of the First Volume of the Geological Report’ has just appeared, and it alone is a quarto volume of 274 pages, illustrated by six coloured maps, several chromo-lithograph views and sections, sixty-six woodcuts, and a beautifully executed photographed frontispiece, showing the glacier-district round Mount Cook, in the Southern Alps of New Zealand. The whole of this book is taken up with a description of the geology of New Zealand, the fossils having been described in several monographs, which have also been very recently published.[*]

The author of the “Geology” (Dr. Hochstetter) remarks that at present it is impossible to refer the strata of these islands to their exact European equivalents, but that he believes all the great formations known to us to be represented in them, from the oldest metamorphic rocks to the youngest sedimentary beds.

In the Southern (middle) Island, metamorphic rocks are extensively developed, and are evidently of great antiquity; then Dr. Haast has found fossils which he considers Silurian, in the slates of Mount Arthur (Nelson), and others in the Southern Alps, most probably Devonian. Next to these formations comes, in point of age, the oldest coal-formation, which contains plants corresponding with those of New South Wales, and is, therefore, most probably Palæozoic. The ages of the Secondary rocks admit of more exact determination, the fossils having been examined by European palæontologists in one of the parts of the “Palæontology” just enumerated. Their researches have proved the existence of the Trias near Nelson, one member of the formation (the Richmond sandstone) having yielded a variety of *Monotis salinaria* in immense numbers, *Halobia Lommeli*, Wissm., *Mytilus problematicus*, Zitt., *Spririgera Wreyi*, Suess, and other fossils of a less distinctive character. The occurrence of Jurassic rocks had before been stated by two or three observers, and Professor Owen four years ago described the remains of *Plesiosaurus australis* from beds near Waipara, inferred to belong to that period. Dr. Hochstetter gives now a number of most interesting details, especially respecting the unconformity of the Tertiary to the Jurassic strata, the former being horizontal, while the latter dip at an angle of 35°.

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[*] ‘Fossile Mollusken und Echinodermen aus Neu-Seeland.’ By Dr. Zittel, Fr. Ritter von Hauer, and Professor Suess. ‘Die Foraminiferen-Fauna des Tertiären Grünsandsteines der Orakei-Bay, bei Auckland.’ By Herr F. Karrer. ‘Fossile Bryozoen aus dem tertiären Grünsandsteine der Orakei Bay, bei Auckland.’ By Dr. F. Stoliczka.

Under the head of "Lower chalk" we find that Dr. Hochstetter classifies the beds containing *Belemnites Aucklandicus*, *Aucella plicata*, &c., at Waikato, Southhead, and those containing the same Belemnite, with *Ammonites Novo-Seelandicus*, and *Inoceramus Haasti* at Kawhia-Haven, although Dr. Zittel states, in the preface to the description of these fossils, that the evidence of the Belemnite and the *Aucella*, as well as of the *Placunopsis* occurring with the latter, is in favour of the beds being Jurassic, while that of the Ammonite and the *Inoceramus* indicates on the contrary their Cretaceous age. Certain coal-bearing beds, having a similar unconformable relation to the Tertiary deposits as the Jurassic strata just noticed, are thought by Dr. Hochstetter to represent either the Upper Jurassic or the Lower Cretaceous period, possibly the Wealden. They contain in the Northern Island a *Polypodium* and an *Asplenium*, and in the Southern Island (in beds probably of the same age) plants belonging to the genera *Neuropteris*, *Equisetites*, *Phœnicites*, *Zamites*, and *Pecopteris*, as well as a Dicotyledonous leaf.

The lowest member of the Tertiary system is a brown-coal formation; but it contains an entirely different flora, including two species of *Fagus*, one of *Myrtifolium*, five of *Phyllites*, &c., all of which, with the other plants, have recently been described by Professor Unger. The overlying marine beds are perhaps more familiar to English geologists than any of the deposits we have mentioned, in consequence of Mr. Walter Mantell's description of them having been published about fifteen years ago, under the auspices of his illustrious father, in the 'Quarterly Journal of the Geological Society.' They include an older and a younger series; the former is considered by Dr. Hochstetter to be probably contemporaneous with the Brown-coal formation, and to include the celebrated Ototara (or Oamaru) series, which the late Professor E. Forbes compared with the Bognor beds, but which Dr. Zittel thinks is much younger. The upper Tertiary deposits are doubtless very recent, but there seems some confusion as to the age of the older series; probably the beds in some localities may be much older than those in others, although now classified together through imperfect knowledge.

The Post-tertiary beds of New Zealand include Lignite-bearing strata, Glacier-drift, Marine and Fluviatile drift (including gold-drift), and all the superficial sub-aërial deposits usually found. But the most remarkable of the sub-aërial formations are undoubtedly the various results of volcanic energy exerted in different ways, and it would occupy the whole of this chronicle were we to attempt to give even an abstract of Dr. Hochstetter's description of them.

We have hitherto said nothing of the physical geography of New Zealand in relation to its geology. Dr. Hochstetter remarks that the three Islands belong geologically to one and the same mass, formed on both sides of a central axis, or axis of upheaval, ranging from N.E. to S.W.; but this is crossed at right angles by a line of depression in the direction of the straits which separate the islands, having a strike from N.W. to S.E. nearly, and corresponding in direction with the line distinguished by Dana as the 'Axis of greatest depression of the Pacific Ocean.' He also says that the extraordinary variety of contour in the surface of the islands is explained by the diversity of their rock-formations, and that the change from mountainous to hilly, undulating, or flat country, from Alpine peaks to swampy flats and elevated plateaux, is always accompanied, or, more correctly, caused, by a corresponding alteration in the subsoil.

It is long since we have met with a work so thoroughly praiseworthy as this one, the more so as it is the result of a Government expedition, and is brought out at Government cost; but they manage these things better in Austria, if we may be allowed to apply the compliment to another country than that for which it was framed. We have given only the barest skeleton (not outline) of the contents of Dr. Hochstetter's book, and as for the several treatises on the Palæontology of New Zealand, though we should have liked to examine some of the points in regard to the distribution of species in ancient time suggested by their perusal, yet we have been obliged to refrain; for it is enough to have to digest at one sitting the characteristics of a new Jupiter, without being obliged to study those of all his satellites.

PROCEEDINGS OF THE GEOLOGICAL SOCIETY.

This quarter we have a very small instalment of the Society's Proceedings, the greater portion of the last number of the 'Quarterly Journal' being occupied by the Annual Report and the President's Anniversary Address.

The Address is prefaced as usual by the Wollaston Awards, mentioned in our last Chronicle, and the obituary notices of deceased Fellows, the list of whom contains many distinguished names, especially Mr. Leonard Horner, Dr. Hugh Falconer, Major-General Portlock, the Duke of Newcastle, the Earl of Ilchester (better known to geologists as the Hon. Mr. Strangways), Professor Hitchcock of Amherst, and Professor B. Silliman, founder of the 'American Journal of Science.'

The President (W. J. Hamilton, Esq.) in the Anniversary Address reviews at great length the chief geological discoveries and investigations made during the past year; but as our readers have already been made acquainted with their chief features, it will not be necessary for us to follow him in this discussion. We must, however, give a brief notice of his attack on the Glacier-excavation hypothesis, which has been so ardently advocated by his predecessor, Professor Ramsay.

Mr. Hamilton admits, of course, the enormously greater extension and thickness of the glaciers during the Glacial Period, and that their eroding power was consequently very much greater than that of their shrunken successors; but he does not believe that power to have ever been sufficient to excavate basins many hundred feet deep in solid rock, and he doubts "whether the position of these deep excavations is such as any amount of glacial pressure could have produced under any circumstances." He distinctly separates the erosion of valleys from the excavation of lakes, as being two distinct questions, and his remarks apply only to the latter.

One President attempts to expose a logical fallacy in the arguments of the other, thus:—According to Mr. Hamilton, Professor Ramsay strives to show that neither a synclinal trough, a line of fracture, an area of subsidence, nor an area of aqueous erosion could have formed the sites of the Alpine lakes, because one is incompatible with existing conditions or phænomena in one case, another in a second, and so on, and that the action of ice is the only other cause by which the form of the ground could have been so modified; were this so, Mr. Hamilton would be quite right in saying, "it does not follow, for instance, that because the Lake of Geneva does not lie in a synclinal trough, it may not be in an area of depression, or that because the Lake of Garda is not in an area of depression, it may not be in a line of fracture." But, if we rightly understand Professor Ramsay, he is scarcely guilty of such an extraordinary piece of sophistry, for it seems to us that he endeavours to show that there is presumptive evidence against *any* of the lake-basins having been produced by *any* of the causes mentioned, the action of glaciers excepted. He does not take one cause for one lake, another cause for a second, &c., and then draw a general conclusion from particular premises. But this question has only a collateral bearing on that of the power of ice to excavate such rock-basins.

There seems to be much more force and justice in another of Mr. Hamilton's series of arguments. He combats the idea of a glacier being able to excavate a great rock-basin like that of the Lake of Geneva, after having emerged from a comparatively narrow gorge-like valley into a vast plain, where it must have reached a state of comparative, if not absolute rest; and he also urges that if the *vis à tergo* be what it is represented (of which, by the way, he seems very sceptical), and if it *did* force the ice into and along the plain, then the upper portion of the glacier would be forced over and along the lower, which would remain almost stationary. Professor Ramsay has stated that he "cannot conceive a horizontal fracture of forty miles in length over the area of the Lake of Geneva, clearly dividing two bodies of ice, the lower of which was when thickest nearly 1,000 feet, and the upper and sliding stratum must have been nearly 3,000 feet thick." Mr. Hamilton, however, states that the meaning is simply that the motion of the ice of a glacier resembles that of the water of a river, being fastest in the centre of the stream at the surface, with a gradual diminution towards the bottom and sides. This kind of motion seems entirely in accordance with natural laws, and quite fatal to the glacier-excavation theory.

Dr. Haast's papers contained in the same number of the 'Quarterly Journal' also relate to this subject; their titles are as follow:—

1. "On the Causes which have led to the Excavation of deep Lake-basins in hard Rocks in the Southern Alps of New Zealand."
2. "On a Sketch-map of the Province of Canterbury, New Zealand,

showing the Glaciation during the Pleistocene and Recent Periods as far as Explored, with an Appendix on the Climate of the Pleistocene Epoch in New Zealand."

Dr. Haast believes that New Zealand was submerged during the Pliocene period, and that, having been subsequently elevated, the chief physical feature of the country was a high mountain range, from which glaciers of enormous volume descended into the plain below, removing in their course the loose Tertiary strata, and thus widening and enlarging the pre-existing depressions, the occurrence of which had at first determined their course. So far most geologists will agree with him, in principle, at all events. But he further endeavours to show that after the glaciers had become to a certain extent stationary (meaning that their termination did not advance or retreat), moraines were formed, and rendered impermeable by glacier-mud; new moraine matter would then, he thinks, raise the bed of the outlet, and the water issuing from the glacier would consequently be forced up through its fissures, until it reached the level of the lowest portion of the moraine. Dr. Haast says that then the ice would be prevented by the moraine from advancing, and would expend its force in excavating a rock-basin near the termination of the glacier. This seems a very extraordinary process, and is singularly in contradiction to Mr. Jamieson's careful observations, which seem to prove that a confined glacier can ascend a slope of considerable steepness.

Dr. Haast's second paper does not seem to be of any great importance; but Dr. Hector's short memoir on the Geology of Otago, is a very valuable addition to our knowledge of the geological structure of New Zealand, especially as it refers to a Province not described in Dr. Hochstetter's work just noticed. This Province seems to have the following geological constitution:—The South-western part is composed of crystalline rocks forming lofty and rugged mountains, and intersected by deeply-cut valleys, which are occupied by arms of the sea on the west, and by great lakes on the east. These crystalline rocks comprise an ancient contorted gneiss, and a newer (probably not very old) series of hornblende slate, gneiss, quartzite, &c.; eastwards they are succeeded by various rocks of Mesozoic age; then follow the great auriferous schistose formations, which comprise an Upper, a Middle, and a Lower portion, and upon these occurs a series of Tertiary deposits, the lowest of which may, however, possibly be of Upper Mesozoic date, while the Upper, consisting of a fresh-water and a marine series, are unconformable to it, and are decidedly much more recent. It will thus be seen, that there are many points of similarity between this Province and those examined by Dr. Hochstetter; but that there are also important differences, notably, in the absence of all mention by Dr. Hector, of the occurrence in Otago of fossiliferous Jurassic and Cretaceous rocks; for the age of his "Mesozoic" rocks is merely inferred from their position and strategraphical relations.

This number of the 'Quarterly Journal' also contains a short but very important paper "On the Coal Measures of New South Wales," by Mr. W. Keene. The author is Examiner of Coal-fields and Keeper of Mining Records for the Colonial Government, and has had, therefore, abundant opportunities of investigating the range of fossils through the different beds amongst which the coal occurs. He states that *Glossopteris* and *Vertebraria* (which Professor M'Coy considers to prove their Mesozoic age) occur from the top of the Coal-measures almost to the bottom; associated with these plants, in some of the lower beds, are *Pachydomus*, *Bellerophon*, *Spirifer*, *Fenestella*, and *Orthoceras*, while a Heterocercal fish occurs higher up, and *Lepidodendron* is found still lower down. The admixture of the Palæozoic fossils with the so-called "Mesozoic" plants appears clearly established; there is no doubt about the age of the former (in a broad sense), whereas the plants do not form a very safe guide, so that at present the Coal-formation of New South Wales must be looked upon as Palæozoic.

The Annual Report shows the Society to be in a remarkably flourishing condition, seventy-five Fellows having been elected during the year. Amongst the new Fellows we cannot help noticing the large number of Civil Engineers (including Mr. M'Clean, Pres. Inst. C.E.); and we are glad to observe the names of several Clergymen, amongst which that of the Rev. H. H. Winwood will be familiar to Members of the British Association. The list also includes the names of many local Geologists of good repute, especially Mr. W. W. Stoddart, the Rev. R. Boog Watson, Mr. H. B. Brady, Mr. George Maw, Dr. Rubidge of Port Elizabeth, and Dr. Atherstone of Graham's Town, while Mr. S. V. Wood, junior, has more than a local reputation. We hope that Geology and Science generally have found a new advocate in another new Fellow, Mr. Reginald Yorke, M.P. for Tewkesbury, and a new investigator in the Hon. A. Strutt, this year's Senior Wrangler.

VIII. MINING, MINERALOGY, AND METALLURGY.

MINING.

THE most remarkable event of the quarter has been the introduction, by Lord Kinnaird, of the "Metalliferous Mines Bill" to the House of Lords—and its withdrawal on the evening appointed for the second reading. It will be remembered, that Lord Kinnaird was the Chairman of the Commission appointed to inquire into the health and safety of the miners working in metal mines. The inquiry instituted by this Commission was an extensive one—and most laboriously have they worked. The result—which has been published in three thick blue books—is summed up in six resolutions, which were submitted, unanimously, by the eight Commissioners to "Her Majesty's most gracious consideration." These may be stated briefly to be—that metal miners die young, and that this is due to imperfect ventilation and to the exertion of climbing on ladders from great depths. That sufficient caution is not employed in the mines—that abandoned shafts are left unfenced and are "a cause of serious danger, not only to the miner, but to the public." The employment of boys underground at too early an age—and the present system of mine-clubs are also submitted as great evils.*

Some causes, which have been hinted at,—but which are not sufficiently clear,—induced all the Commissioners, except Lord Kinnaird, to avoid proposing any legislative application, to remedy the evils which they had themselves pointed out. That nobleman, actuated by the most humane intentions, took upon himself the burthen of preparing a Bill, by which he hoped to remedy some of the existing evils. Lord Kinnaird desired to avoid the machinery of a large body of Inspectors, and he proposed the formation of a Board of practical men, who, with a few Inspectors at their command, might see that remedies were applied where they were thought to be necessary. At this idea of a Central Board, the miners, especially of Cornwall, took alarm, and a powerful opposition was organized. The influence of this has been, that—especially as the Government expressed their intention of opposing Lord Kinnaird's Bill, if it was pressed this Session—the framer has withdrawn it, expressing his intention to introduce an amended Bill, which will stand over for consideration early in the next Session.

It is by no means desirable that legislative interference should take the place of any existing desire to remedy acknowledged evils. It is stated that improvements have been gradually, and are being continuously, introduced into the system of working our metal mines. If this be so, then let us hope that evidence will be given of it so strongly between this and next year, as to remove every argument which may be brought forward for the introduction of another Metal Mines Bill. We regard all attempts to improve the working classes by legislative means as a blundering way of arriving at a desired end. Let the working man, and the employer equally, be taught, in the first place, to feel that their interests are identical—and then be instructed in those truths which improve the powers of observation, and enable them to see the existing evils, and apply the proper remedy. We may depend upon it, the individual effort will effect a much greater reform than will be possible with the best constituted Board.

Great interest attaches itself to the phenomena of the diffusion of gases, which appear to have been noticed in the first instance by Dr. Priestly,† and subsequently investigated by Dr. Dalton ‡ and by M. Berthollet.§ Döbereiner, in 1825, also made some remarkable observations, but for the full investigation of the subject we are indebted to Professor Graham.‖ It has been long known, that gases which do not enter into chemical combination will diffuse themselves through one another, though kept externally at perfect rest, and form a uniform mixture, though their specific gravities may be very different. Professor Graham, by the use of a very ingeniously-constructed instrument called a *diffusiometer*, has obtained an exact measurement of the rate at which this interchange takes place. He found that the diffusion of gases through porous septa is regulated by the same law as when they communicate freely with one another, *namely*, that *the relative diffusibilities are inversely as the square roots of the densities.*

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* The whole question has been dealt with by Dr. Angus Smith, F.R.S., in two papers in the 'Quarterly Journal of Science,'—"On Metal Mining," No. v. p. 59; "On the Health of Metal Miners," No. vi. p. 216.

† 'Experiments and Observations on Different Kinds of Air.' Vol. iii. p. 29.

‡ 'Philosophical Magazine.' Vol. xxiv. p. 8.

§ 'Mém. d'Arcueil.' Vol. ii. p. 463.

‖ 'Elements of Chemistry.' Second edition. Vol. i. p. 87.

A very beautiful application of the Diffusion of Gases has been recently patented by Mr. G. F. Ansell, of the Royal Mint. In our coal mines, there are not unfrequently, evolved from the coal beds, considerable quantities of light carburetted hydrogen gas. This gas mixing with atmospheric air, forms the explosive fire damp, from the ignition of which the most disastrous consequences too frequently ensue. Mr. Ansell's object has been to construct an instrument which should indicate the presence of this gas in any part of the coal mine—give warnings of its presence—and, indeed, measure the percentage quantity in which it exists relatively to atmospheric air. We have given drawings of some forms which Mr. Ansell's instruments have taken, and a description of those will sufficiently explain their action under the influence of the diffusing gas.

Carburetted hydrogen gas,—either *heavy*, as ordinary coal gas, or *light*, as marsh gas or coal-mine gas, though lighter than air,—diffuses itself readily through air. Upon this is founded the method for detecting its presence. Fig. 1*a* is a small balloon of india-rubber filled with atmospheric air, bound around the middle with a band of linen, to prevent lateral expansion. This is placed under the lever (*b*), resting on a stand at (*f*), where there is a screw to adjust the bag of air to a proper height. When adjusted, the balloon presses lightly upon the lever (*b*) already referred to. If this arrangement is placed in an atmosphere containing but a small percentage of carburetted hydrogen, this gas passes rapidly through the india-rubber by diffusion, and, of course, expands the balloon. In expanding this, the lever is raised; and by the arrangement shown at (*c*), the rachet wheel is released, and the cord and weight (*d*) liberated, and in the fall of the latter down the pillar, a bell is rapidly and repeatedly rung. By the same form of apparatus, connection may be made, or broken, with a voltaic battery, or a magneto-electric machine put in motion, and a telegraphic signal given at the surface of the mine, either in the office or in any convenient place.

Fig. 2 is another form of the instrument. A cup of mercury is inclosed in a cell of porous earthenware, through the top of which a tube passes to the bottom of the mercury. On the surface of the mercury, in the tube, is a floating weight attached to a string, which is carried over a pulley, and, by its rise or fall, moves an index upon a dial, precisely in the same manner as in the ordinary wheel barometer. The gas, even when it exists in the smallest quantity, passes into the porous cell, and thus increasing the volume of the inclosed air, it presses the mercury up into the tube, lifting the float, and thus moving the index. This arrangement may be made to ring a bell, or to establish electro-telegraphic communication.

Fig. 3 is a glass U tube, holding a little mercury or coloured water. This is fixed upon a board, on which is a scale graduated by experiment. Over one arm of the tube is fixed a porous plate. A superior material for the porous plate has been found in the artificially-compressed graphite of Mr. Brockeden. It is sold for making pencils in small two-inch cubes. This is easily cut into slices by means of a steel spring saw, and by rubbing it on a piece of flat sandstone, it may be reduced to any degree of thinness. A circular disc of this substance, about the size of a wafer, is placed over one arm of the **U** tube. This is carried into the colliery, and the percentage of gas in the air is shown by the rise of the fluid in the open arm of the tube.

Fig. 1.

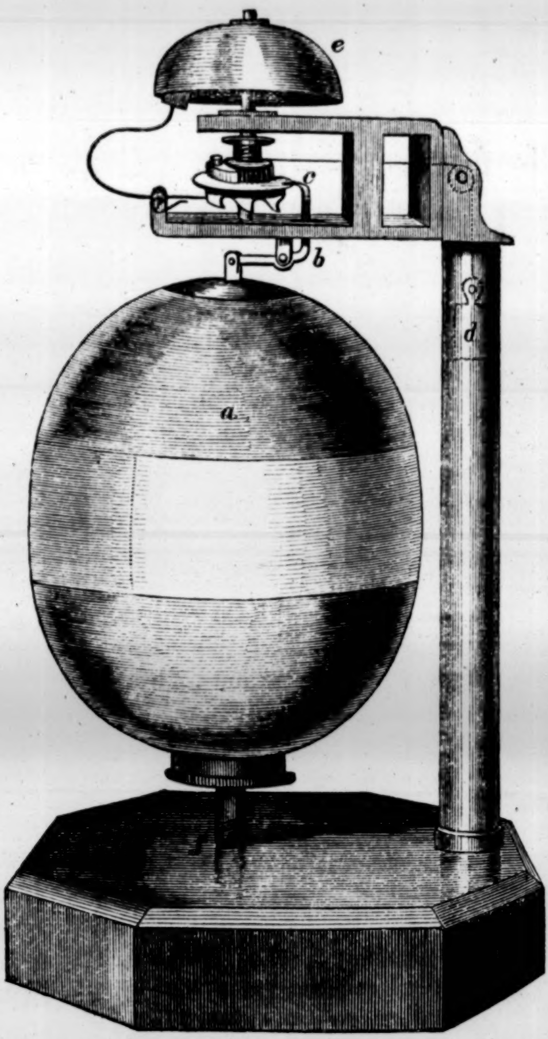


Fig. 4 is a section of a porous cell to be used with the apparatus shown in Fig. 3. Fig. 5 consists of (*a*) a porous tile secured into a glass vessel (*b*), which is connected with a **U** tube having some mercury in it. The arrangement is then made as in the former case, so that the index is moved the moment diffusion takes place.

FIG. 2.

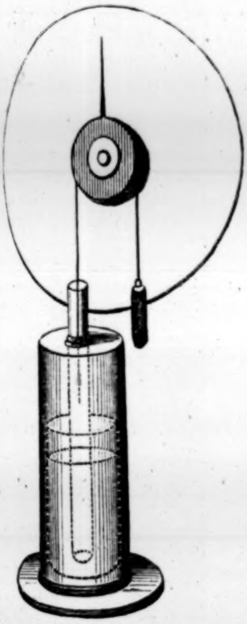


FIG. 3.

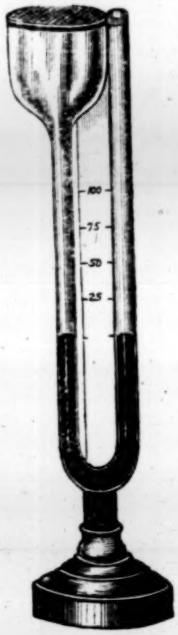


FIG. 4.

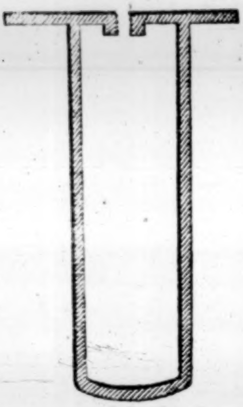
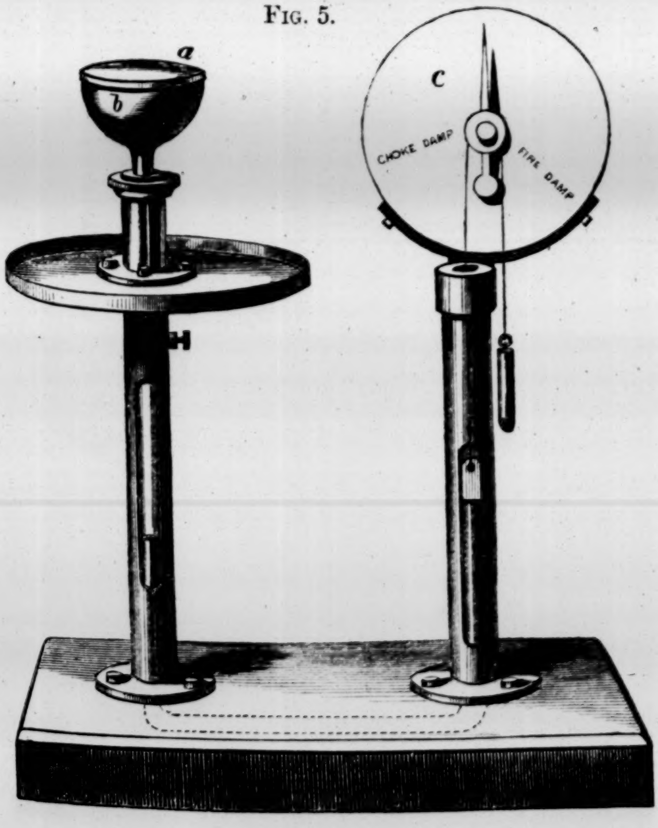


FIG. 5.



There are many other forms which might be given to this apparatus. Indeed, Mr. Ansell has nearly completed one of a most portable description, which is about the size of an old-fashioned watch. It can therefore be carried into the colliery by the viewer in his pocket, and employed at any moment to determine the amount of dangerous gas present in the air.

When the diffusion has been completed, that is, when the air within and without the porous septa has become of the same character, the index ceases to move. To restore the index to zero,—which is bringing it back to its normal state,—nothing more is necessary than to place it, for a few minutes, in atmospheric air which is free from carburetted hydrogen.

We have rarely seen a more refined application of science than this, and we cannot but believe it will be found of great practical utility as indicating the presence of fire-damp in collieries, before it becomes dangerous from accumulation.

In our second Number (April, 1864), we directed the attention to the production of gold from the Quartz veins of the rocks near Dolgelley.

It appears that at Vigra and Clogau, above 1,600 tons of auriferous quartz have been operated on during 1864, and from that quantity upwards of 11,000 ounces of gold have been obtained.

The quantities of gold produced in the whole district during last year were as follows:—

	Gold Quartz.		Gold.		Value.
Vigra and Clogau	1,679	tons, yielding	2,331	ounces,	£8,434
Cefn Coch (Welsh Gold Mining Com.)	604	"	346	"	970
Castell carn Dochan . . .	29	"	141	"	394
Hafod-y-Morfa, Prince of Wales' Mine .	20	"	63	"	176
Gwynfynydd	4½	"	6	"	17

Some very interesting and important experiments are now in progress for the purpose of testing, on a large scale, a discovery which has been recently made by Mr. William Crookes, F.R.S., in connection with the process of amalgamation by which the gold is separated from the other matters with which it is mixed. For a long period, the "sickening" of the mercury, as it is technically called by workmen, has been a source of much annoyance and loss. When sulphur ores, arsenic, bismuth, or tellurium are present, the fluidity of the mercury is destroyed, and it becomes either a tenacious mass or it assumes a powdery character; in either case, becoming useless.

Mr. W. Crookes has entirely removed this difficulty by combining a little sodium with the mercury. This preserves the fluidity of the mercury under all circumstances, and, of course, its amalgamating powers. Not merely this, but the sodium amalgam is a preservative against the injurious action of grease in the process. As we have said, extensive experiments are now in progress. Nothing can be more satisfactory than this process appears to be; but the whole subject is so full of interest, that we prefer waiting until we are furnished with a detailed statement of the results,—which we are promised,—when we hope to devote an article to the consideration of the gold rocks of North Wales, and the processes which have been used, at home and abroad, for the separation of the gold.

The following statement has been handed to us. It shows the total quantity of gold obtained from the neighbourhood of Dolgelley up to the end of 1864:—

	Oz.	Dwts.	Grs.
Old Dolfrwynog	117	5	5
Prince of Wales	63	0	0
Cwmheisian	176	0	0
Gwynfynydd	6	2	3
Welsh Gold Company	478	17	23
Castell Carn Dochan	183	15	3
Vigra and Clogau	10,778	0	0
Total	11,802	0	10

MINERALOGY.

M. Haidinger* has called attention to some very curious stalactites of green carbonate of copper found in a mine which has been long abandoned at Reichenau, in Austria. The mine had been originally worked for carbonate of iron, and iron and copper pyrites. These stalactites had resulted from the decomposition of the pyritic ores. M. Haidinger supposes that the carbonate of copper had been precipitated in a pulverulent state, carried forward by water, and slowly consolidated under the influence of crystallization. Many of these crystals present a rough and black surface, which appears to be black oxide of copper. A series of curious metamorphoses have evidently been going on between the formation of sulphate of copper, by the decomposition of the sulphides of iron and copper, and the formation of the carbonates and black oxides.

A mountain of iron, rivalling, says the Abbé Moigno, "celles si fameuses de Marquette," has been discovered upon the borders of Lake Superior. A certain quantity of this iron ore taken from a depth of about sixteen feet from the surface, and smelted in an ordinary furnace, has given 60 per cent of iron, which is nearly equal to our finest red hæmatites.†

M. Kuhlmann is continuing his important inquiry on crystallogenic force. He has recently communicated to the Academy the fourth part of his memoir on this subject. It is not possible to present an abstract which would convey any satisfactory idea of the principles involved in the consideration of this subject. We must refer our readers to the original memoir.‡

M. Henri St. Claire Deville has communicated to the Academy of Sciences two notes by M. Felix Pisani. The first is on *Kalicine*, a new mineral species from Chypis, in Valais; and the second on the *Pisolitic Limonite*, of Iwaro, upon the Lake Œdenburg, in Hungary.

Kalicine was discovered in the fine collection of M. Adams, under the name of carbonate of potash, and proved by analysis to be identical in composition with the bicarbonate of the laboratory. This mineral has been met with at Chypis—under a dead tree—an aggregated mass of infinitely small crystals, translucid, and of a yellow colour. Analysis gives potassa 46·6; carbonic acid, 42·2; carbonate of lime, 2·5; carbonate of magnesia, 1·35; sand and organic matters, 3·60; water, 7·76. This composition corresponds to the formula $K\,C^2 + A$,. It is the first example of carbonate of potassa being found in nature; and, it is evidently, of recent formation.

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* Institut Impérial de Géologie, Séance du 20 Décembre, 1864.

† 'Les Mondes,' 12 livraisons, p. 502.

‡ See 'Comptes Rendus' and 'L'Institut,' May 17, 1865.

The Limonite of Iwaro is attributed to meteoric origin, and the date assigned to its fall is the 10th August, 1841. An analysis made by Redtenbacher proves that it is formed of sand—oxide of iron and oxide of manganese, with a little carbonate of lime and alumina. M. Pisani conceiving that, if of meteoric origin, this *Pisolitic Limonite* should contain nickel, and cobalt, has made a new analysis, which gives:—

Argillaceous Sand	58· 9
Oxide of Iron	11· 0
Oxide of Manganese	10· 1
Oxide of Cobalt and Nickel	0·85
Alumina	3· 7
Lime	1·45
Magnesia	0·72
Water	13·06

At a recent meeting of the Académie des Sciences de Vienne, a memoir, by M. de Zepharovich, was read—"On the Crystallization of Anglesite" (sulphate of lead). The examples obtained by M. de Zepharovich were from the lead mines of Schwarzenbach and Miss, in Carinthia. This memoir may be regarded as a companion one to the work of M. V. de Lang, upon the crystals of the same species of mineral of Bleiberg.*

The crystals obtained at Schwarzenbach are remarkable for their limpidity, and for the great number of their planes, appertaining to seventeen different crystallographic forms. Three of these forms were new—two pyramids, and one "un *doma*" or horizontal prism.

The two first forms are found equally frequent upon the crystals from Miss, which, in other respects, are of a totally different type from those of the crystals of Schwarzenbach. In both these localities the Anglesite is found upon the Galena—more or less decomposed—associated with oxide of iron; and at Miss the crystals of cerussite (carbonate of lead) are evidently of two different epochs of formation.

Mr. N. Story Maskelyne has communicated to the Royal Society a paper "On New Cornish Minerals of the Brochantite Group." These minerals have been already noticed in our Journal.

Professor A. H. Church has communicated a paper on the same subject, entitled "On some Hydrated Cupric Oxychlorides from Cornwall" and another "On some Hydrated Cupric Oxysulphates," to the Chemical Society.†

The mineral Phosphorite, which was stated to occur in large

* 'Comptes Rendus Académiques' de 1859.

† 'Journal of the Chemical Society,' March, 1865.

quantities in the district of Estramadura, in the South of Spain, has been recently analyzed by Dr. Forbes, F.R.S. The specimens received, though in large blocks, consisted of pure phosphorite, apparently unaccompanied by any other minerals; the mineral itself was massive, and, on breaking, the fracture was uneven and earthy, disclosing a slightly radiating dendritic structure, but no trace whatever of crystallization. The colour of fresh fracture was chalk-white, but weathered surfaces frequently showed a dirty or rusty white colour externally. Lustre earthy; opaque; streak and powder dead white. Hardness about 4·5. The specific gravity was taken on two distinct specimens, and found to be 3·00 and 2·92 respectively at 60° Fahr. The result of a very careful analysis gave the following composition:—

Fluoride of Calcium	8·01
Chloride of Calcium	0·16
Lime	41·03
Magnesia	0·12
Alumina	1·75
Sesquioxide of Iron	1·19
Phosphoric Acid	44·12
Sulphuric Acid	trace.
Carbonic Acid	0·40
Insoluble matter	1·41
Water	1·44
Total	99·63

METALLURGY.

M. Pastera, Chemist of the Department of Mines and Works, has been experimenting at Vienna on some new processes for the extraction of the gold disseminated in argentiferous minerals. Each metal is extracted separately—the gold by chlorine water, and the silver by a solution of salt, or by hot water after the silver has been converted into a sulphate by a roasting process. M. Pastera, after having made his first experiments on a small scale, proceeded to treat the roasted ores from Nagyag, in Transylvania, and he obtained the most complete success.*

Attention has again been drawn to the question, whether the molecular condition of metals, especially iron and steel, alters by continued vibrations or repeated percussion.

At a recent discussion on the Submarine Atlantic Cable, the liability to this alteration was insisted on as though it were a proved fact,† and in an established periodical,‡ it is implied that Mr. Sorby's microscopic researches have established the fact. It should be clearly understood by all, that there are not any experiments which confirm this statement, although there are many which at first appear to prove its correctness. Mr. Brunel showed that the same piece of good iron might be broken with either a fibrous or a crystalline structure. The first condition requiring dull and heavy blows—the second demanding sharp and violent ones. It is most probable that vibratory action of any kind, long continued, is liable to change the structure of metals; at the same time none of the experiments which have been made appear to have been sufficiently conclusive, and all the results obtained can be explained, as Brunel explained them, by the nature of the breaking blow. Seeing the important uses to which iron and steel are applied, it is surely desirable to determine this problem beyond all doubt.

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* Institut Impérial de Géologie, Vienna.

† 'Phil. Mag.,' May, p. 340.

‡ 'Society of Arts Journal,' May 12, 1865.

We are desirous of recording every step, which may ever promise to be an advance in any of our Metallurgical operations. The Messrs. Woodwards, of Ancoats, have been making experiments on the smelting of pig-iron in the ordinary cupola, through the agency of steam. The great object being to get rid of the fan and its mechanical accessories. As we understand the arrangements, it appears to be the use, in a modified form, of the steam jet, as used by Goldsworthy Gurney, for ventilation, and as employed in our locomotive engines. At the upper part of the cupola, immediately above the part where the charge is put in, a steam pipe 1¼ inch bore is inserted into a wrought-iron chimney equal in length to the depth of the cupola below. Such is the arrangement. The fire is lighted, and the charge made in the usual manner. The door of the charging hole is then closed, and the steam is turned on. The rapid current of steam rushing through the chimney carries the air with it, causing a momentary partial vacuum immediately above the fuel and the metal. The only place through which air can enter is below—and there through ten openings it rushes in with a velocity which is regulated by the force of the steam jet. This arrangement is said to secure a general and uniform heat throughout the furnace, and to produce more perfect combustions of the fuel. For smelting a ton of pig-iron it is stated that little more than 1 cwt. of coke is required, while the bringing down of the molten metal is effected more speedily.

A further improvement in this apparatus is in progress. The upper portion of the cupola will be surrounded by a boiler, from which steam will be supplied to the fire. Thus, after the furnace has fairly started, it will, by its own heat, generate the steam by which the work is to be performed.

Some time since, our newspapers informed us that a wonderful iron letter was sent to this country from Pittsburgh. This was a sheet of iron so thin, that it required 1,000 of such sheets to make one inch in thickness, the dimensions being 8 inches by 5½ inches, or a surface of 44 inches, and weighing 69 grains. Soon after, there was produced, at the Marshfield Iron Works, Llanelly, a sheet of the same size which weighed only 48 grains. This was soon followed by a sheet of iron, made at the Hope Works, in Staffordshire, with a surface of 118 inches, which weighed but 89 grains. This, reduced to the American standard of 44 inches, gives about 33 grains. While Messrs. R. Williams and Company made a similar sheet weighing but 31 grains, the Marshfield Company, desiring not to be outdone, soon succeeded in making a sheet of 44 inches, which weighed only 23¼ grains, and required no less than 2,853 sheets to make one inch in thickness; and eventually they made another sheet of 48 surface inches, which weighed 25 grains, and required 2,950 sheets to make one inch in thickness. At the Pontardawe Tin Works there was subsequently made a sheet having a surface of 115·17 inches, weighing 60 grains. This was a trifle heavier than the Marshfield sheet, but Pontardawe claims 3,799 sheets to make a thickness of one inch.

All this has, however, been outdone at the Upper Forest Tin Works, near Swansea, of Messrs. W. Hallam and Company. At their mills, a sheet of iron has been produced with 55 inches surface, and weighing but 20 grains, which, being brought to the standard of 44 inches, is but 16 grains, or 30 per cent. less than any previous effort, requiring at least 4,800 sheets to make one inch in thickness.*

Steel made at the Ebbw Vale works, by Mr. Parry's patent, has been rolled into exquisitely thin plates. The thinnest is said to have been ·001 in thickness, perfectly tough, smooth, and free from holes.

The Royal Academy of Sciences of Belgium has given its gold medal to Captain Caron, as the author of the best work on the constitution of steel. M. Straas, who was chairman of the committee appointed to examine the essays sent in, makes high commendation of Captain Caron's work. He expresses his entire concurrence in his opinion, that iron, in passing into steel, does not take up any nitrogen in addition to that which it already contained. Steel, M. Straas remarks, is essentially composed of iron and carbon, and owes its qualities or its defects to two different causes—the state of carbon in the metal, or the nature of the foreign bodies which debase it. Whenever steel is good, its carbon can, under the influence of tempering, combine with the metal, and give us a hard, brittle metal, which further tempering renders supple and elastic. When steel becomes hard after undergoing several heatings, it is due to its carbon having been burnt or separated from the iron, and tempering will not then regenerate the combination. This separation is due to the presence of foreign bodies, more especially silicium. M. Straas concludes by saying, "Captain Caron's Essay is undoubtedly the *résumé* of long and glorious labours, put forth with a simplicity and lucidity which greatly enhance their merits." There will be many a dissentient voice in this country to the somewhat dogmatic statements of M. Straas.

PHYSICS.

LIGHT.—Spectrum-analysis has recently performed a somewhat important service to chemistry. Besides the well-known chemical elements, and those new ones, such as Cæsium, Rubidium, Thallium, and Indium, which have after a long or short probation been definitely admitted into the family of elementary bodies, there are several substances waiting, as it were, on the threshold admitted as elements by some chemists, but branded as compounds by others. In most cases not sufficient was known about them to enable the most impartial judge to decide one way or another. Amongst these two bodies, Erbium and Terbium, have long been kept in the same undecided state, and there is no knowing how many years more the verdict "not proven" might have been recorded against them had not spectrum-analysis come to their aid and substantiated their right to enter the family of elements. M. Bahr first discovered the absorption spectra of Erbium and Terbium, and they have since been submitted to a more extended investigation by M. Marc De la Fontaine. These bodies appear to be intimately associated with the element Didymium, the spectrum of which was discovered by Dr. Gladstone. A very dilute solution of nitrate of didymium shows three rather indistinct black rays, shown in Fig. 3 by the letters *a*, *b*, *c*. In strong solution other lines appear, and the complete spectrum is shown in Fig. 3. On examining a strong solution, a salt of Erbium gives a spectrum having eight bands of absorption, as shown in Fig. 1, and five when in weaker solution. Terbium when in solution gives only the rays shown in Fig 2, and no more make their appearance, however concentrated the liquid is made.

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* Most of these particulars have been obtained from the 'Mining Journal.' The remarks on steel plates are from 'The Engineer.'

The positions in respect to the coloured rays of the spectrum may be obtained by reference to the graduated scale, on which the red Lithium line = 10, the yellow Sodium line = 27, and the green Thallium line = 43.

As will be seen, two bands are common to the three elements, *viz.* Di_b, Tr_b, Er_a, and Di_c, Tr_c, Er_c, whilst Er_f is identical with Di_h.

In a former note we mentioned that Father Secchi had investigated the so-called *telluric rays* in the solar spectrum, and had arrived at the conclusion that they were due to the absorptive action of aqueous vapour. From a recent communication to the French Academy of Sciences we learn that the Reverend Father has repeated his observations with a more perfect spectroscope, and has been enabled to confirm his former results.

Dr. Gladstone, F.R.S., in conjunction with the Rev. T. P. Dale, M.A., has been for some time past investigating the Specific Refractive Energies of the Elements and their Compounds.

In 1863 they communicated a paper on this subject to the Royal Society and at the meeting of the Chemical Society, in May last, some further results of their joint labours were brought forward. The "specific refractive energy" of a body is a constant, and not affected by temperature, and is arrived at by dividing the refractive index of the substance (μ) minus 1, by the density. The formula already proposed was found to hold good on a more extended investigation of the subject, and the authors generally worked with the fixed line A. The proposition resolved itself into a study of the inquiry whether the specific refractive energy of an element was invariable under all circumstances of isolation or combination, and whether this property in the case of a compound was correctly expressed by taking the mean of the refractive energies of its several elementary constituents. As a

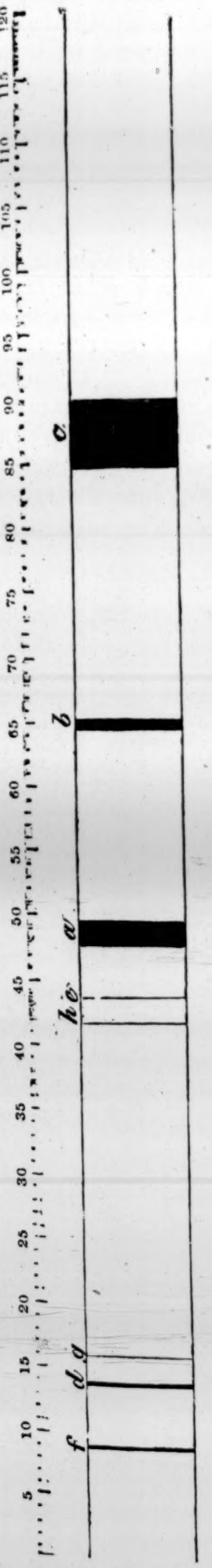

Fig. 1.—Erbium.

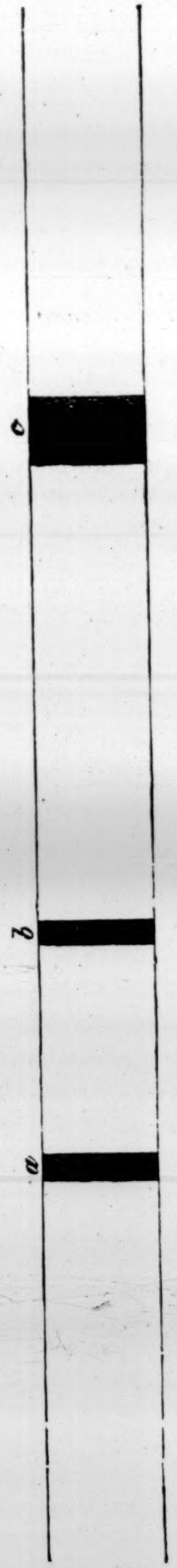

Fig. 2.—Terbium.

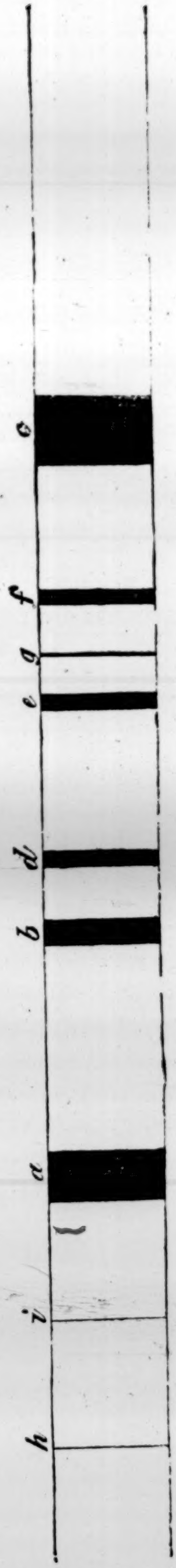

Fig. 3.—Didymium.

general rule this was found to be the case, but the authors brought forward a few exceptional instances which at present appeared to stand in opposition to their statement. Dr. Gladstone particularly referred to sulphurous acid, hydrated sulphuric acid, and aqueous tartaric acid, as presenting anomalies which were considered worthy of more extended investigation, with the view of determining the nature of the disturbing causes. This mode of physical research is interesting in connection with the study of isomerism, and will probably lend valuable aid in determining the internal constitution of bodies; thus, whilst aniline and its isomer, picoline, gave widely different results under this optical treatment, it had been found by Landolt that a mixture of equal equivalents of methylic alchol and acetic acid behaved precisely like its theoretical conjugate, glycerin. Dr. Gladstone exhibited in a tabulated form the numbers representing the specific refractive energies of many of the elements, multiplied by their atomic weights, or "refraction equivalents," as Landolt terms it, and he worked several examples by way of showing the application of the formula, and the mode of deducing from compound bodies the value of each constituent. The table stood thus:—

Name of element.	Refraction equivalent.
Carbon	5·1
Hydrogen	1·5
Oxygen	3 0
Nitrogen	3·3
Chlorine	8·5
Bromine	15.7
Iodine	24.4
Sulphur	16·0
Phosphorus	18·6
Tin	22·0
Sodium	6·0
Mercury	11·0

With regard to the value of carbon it was shown that the number observed in the case of the diamond agreed with the results deduced from the examination of carbonic oxide, carbonic acid, olefiant gas, and a variety of liquid hydrocarbons. Hydrogen did not appear to have precisely the same value in the form of gas that it had in certain hydrogen compounds, and the author stated that 7·6 was the average expression, from a great number of experiments, of the value of CH_2, the oft-quoted increment of carbon and hydrogen in the homologous series. Nitrogen in the form of gas was 3·3 as above, but in combination its value sometimes amounted to 4·2. In a similar manner the numbers representing oxygen and chlorine gases became subject to modification when those elements were combined.

Some novel experiments have been lately described before the Chemical Society of Paris, by M. Jodin, illustrating the action of light on vegetable matter. The author destroys the vitality of green leaves by immersing them in alcohol, or heating them to a high temperature in sealed tubes, and finds that after this the leaves still present some signs of life. In the light they are rapidly decolorized, but excluded from air and light they preserve their greenness for an indefinite time. In the course ofthe decoloration by solar light, he proves that oxygen was absorbed and carbonic acid evolved. Under the same circumstances he finds the yellow matter in etiolated leaves to absorb oxygen. On the contrary, it is proved that etiolated leaves, in becoming green in the light, evolve oxygen, while those kept in the dark and unchanged in colour absorb oxygen. The author is disposed to regard chlorophyll as a body quite distinct from the yellow colouring matter of leaves.

The magnesium light promises to be of important use for lecturers and physical experimentalists. M. Lallemand, of Versailles, has found that it is sufficiently active to determine the combination of hydrogen and chlorine. The explosion may be effected with the light of a single wire burnt in a spirit lamp.

Whilst referring to the explosion of hydrogen and chlorine it may be of interest to many of our readers if we give in detail the mode of preparing the sealed bulbs containing exactly equal volumes of chlorine and hydrogen gases, which have been employed by Dr. Roscoe for exhibiting the chemical combination of these gases effected by the action of light. The process was fully described by Dr. Roscoe himself at one of the recent meetings of the Manchester Literary and Philosophical Society. The apparatus needed consists of a stout tube or narrow bottle of about 120 cubic centimetres capacity, fitted with a caoutchouc stopper with three holes bored through it. Into one of these holes a vent gas delivery tube passes, on to which three small wash bulbs are blown; into the other two holes are inserted the rounded ends of two lengths of the gas carbon, commonly used as terminals for the electric lamp; these poles are of such a length that they pass to the bottom of the glass bottle. This is then filled with strong aqueous hydrochloric acid, containing about 30 per cent. of the anhydrous acid; the stopper in the poles and wash bulbs containing a few drops of water is then fixed into its position, and the evolution vessel placed in a beaker of cold water, whilst contact is made with the terminals of four ordinary-sized Bunsen's cells, the whole apparatus being placed in a dark room. The mixed gases at once begin to be given off, and ought to pass through the wash bulbs at the rate of about two bubbles per second. It is absolutely necessary that the gas be allowed to come off at this rate for three hours before it is collected, as up to this time it does not attain a sufficient degree of purity and sensitiveness, whilst after the lapse of this time it is generally found to be fit for use. In order to absorb the excess of chlorine, the waste gas may be led into a condenser containing slacked lime and charcoal in alternate layers. When the evolution has gone on for the above-mentioned time, a bulb tube, connected by caoutchouc joinings, is placed between the evolution vessel and the condenser, and the gas allowed to pass through. The bulbs, which are made of fusible glass tubing, are blown about the size of a hen's egg, and so thin that they easily break when pressed with the finger. At each side of the bulb the tube is drawn out so as to be very thin in the glass, and to leave the internal diameter not less than 1 mm., whilst at the extremities the tube is wider, so as to fit ordinary joinings. When the gas has passed through the tube for about ten minutes, the joinings are loosened and each end stopped with a piece of glass rod. The bulb tube thus closed is then removed from the evoluting vessel, and the thinnest part of the tube brought some little distance above a very small Bunsen's flame; the glass then softens below a red-heat, and the ends may be drawn out and sealed with safety. It is advisable to number the bulbs, and to test the first and last by exposing them to a strong light. Frequently, in spite of every precaution, the gas explodes during the act of sealing, so that in this operation it is advisable to hold the bulb with a cloth rather than in the open hand. As soon as one bulb-tube is removed, another is placed in connection with the evolution flask, and, after ten minutes, sealed as described. The above quantity of acid will serve for the production of sixty bulbs. Thus prepared, the sealed bulbs may be kept in the dark for any length of time without injury; some, which were known to have been made more than a year, were found to be perfectly good. To explode these bulbs it is only necessary to expose them to diffuse daylight or sunlight, when the combination occurs instantly. Of artificial lights, the bright flash produced by the combustion of the vapour of bisulphide of carbon in nitric oxide is most effective; but the light of burning magnesium wire, of phosphorus in oxygen, or the electric light, answers perfectly well. Professor Roscoe stated that Mr. Dancer, of Cross Street, had undertaken to supply the bulbs to persons unable to prepare them.

At the April Meeting of the same Society, Mr Dancer brought forward some curious experiments in pseudoscopic vision through prisms. If we look with both eyes at an object, such as the flat top of a table, for example, and then interpose a prism between one eye and the object, we discover, after a short time, that the portion of the surface to which the sight is particularly directed has apparently changed its distance. If, in trying the experiment, the thin edge of the prism is turned inwards to the nose, the flat surface will appear concave; if, on the contrary, the base or thick edge is turned towards the nose, the surface will appear convex. The full effect of this alteration in the appearance of the object is not realized immediately, some persons see it perfectly in a few seconds, others require some moments of steady gazing before it becomes evident to them. The character of the surface to which the vision is directed exercises some influence in producing the effect. A circular table covered with a cloth of a bright pattern, having a few articles disposed towards the edges, exhibits this fallacious vision in a marked degree. The angle of the prisms for showing these experiments should be about 15°; if less than this, the elevation or depression of surface is not sufficient to produce a good effect; if the angle is much greater than 15°, many persons are unable to unite the refracted image of the prisms with the real image seen by the other eye. Achromatic prisms are much to be preferred in these experiments to those which are uncorrected for colour. Experiments with these prisms have shown that the power of converging the optic axes differs very considerably in individuals. The pseudoscopic effects are exaggerated by using a prism to each eye, but in most persons this produces a painful sensation. The explanation of these phenomena, which Mr. Dancer offered, and which seems to be the correct one, is based upon the supposition that in binocular vision we estimate the distance of an object by the degree of convergence of the optic axes. In these experiments, when a flat surface appears concave by the interposition of the prism, the optic axes are made to converge on a point situated behind the real surface, and the imagination gradually removes the object to this apparent distance. When the base of the prism is towards the nose, then the flat surface becomes convex: in this case the optic axes cross in front of the real surface, and the imagination raises the object to that point.

M. Dode, a French chemist, has introduced platinum mirrors, which are greatly admired, and which present this advantage, that the reflecting metal is deposited on the outer surface of the glass, and thus any defect in the latter is concealed. The process, which is patented in France, is described as follows:—Chloride of platinum is first made by dissolving the metal in *aqua regia* and driving off the excess of acid. The neutral chloride is then dissolved in water, and a certain quantity of oil of lavender is added to the solution. The platinum immediately leaves the aqueous solution and passes to the oil, which holds it in suspension in a finely-divided state. To the oil so charged the author adds litharge and borate of lead, and paints a thin coat of this mixture over the surface of the glass, which is then carried to a proper furnace. At a red heat the litharge and borate of lead are fused and cause the adhesion of the platinum to the softened glass. The process is very expeditious. A single baking, M. Dode says, will furnish 200 metres of glass ready for commerce. It would take fifteen days, he says, to coat the same extent with mercury by the ordinary plan.

Photographers have for many years been endeavouring to substitute salts of uranium for salts of silver. One of the most promising of the different suggestions for this purpose has just been made by M. Liesegang. He prepares an ammoniacal citrate of uranium and mixes it with a little solution of chloride of gold and a paste prepared by dissolving tapioca powder in hot water. The quantity of chloride of gold must be small, and the heat not too great, otherwise the gold will be reduced. Spread this mixture with a sponge on paper, which takes a brilliant yellow colour, similar to albuminized paper; when quite dried in the dark, place it in the positive frame. The proofs have all the force and delicacy of those obtained by albuminized paper; the preparation is very sensitive, and becomes more so if slightly moistened. The proofs come from the frame of a bluish black colour; they should not be toned, and should be fixed by being washed with rain-water until the yellow colour of the paper completely disappears.

The picture may be changed to purple by a solution of chloride of tin.

HEAT.—M. H. St. Claire Deville has been for many years occupied with the curious subject of *dissociation*, and on May 1st he presented to the Academy of Sciences a memoir on the phenomena of dissociation in homogeneous flames. It related to the chemical composition and the distribution of heat in a flame produced by a mixture of oxygen and hydrogen, or carbonic oxide and oxygen burnt from an oxy-hydrogen blow-pipe. The author in this paper describes the results with carbonic oxide and oxygen, mixed in the proportion to form carbonic acid. The flame is seen to be composed of an outer and inner cone; the latter composed of the uncombined gases, the former of the gases in combustion. The interior cone had a height of about 10 millimetres, while the more visible part of the exterior cone rose to 70 or 100 millimetres.

The observations show,—

1. That the temperature goes on increasing from the lower part of the flame up to the summit of the interior cone.
2. That the proportion of uncombined gases (oxygen and carbonic oxide) to the combined gas (carbonic acid) increases from the upper part of the dart of flame, where carbonic acid alone was found, down to the lower part (summit of interior cone) where only two-thirds of the oxygen and carbonic oxide had united.

M. Tresca, whose experiments of the flow of solid bodies (soft metals and ceramic pastes) from a small aperture when submitted to great pressure, are known to our readers, has now extended his researches to ice. This body is found to issue in exactly the same way as the solids above mentioned. The jet is formed of perfectly distinct concentric tubes, which, however, in this case are grooved through their entire length with transverse fissures which gave to the jet the appearance of being made up of washers arranged one after another. The results support strongly Dr. Tyndall's theory of constitution of glaciers. Some effects resembling *moraines* were, indeed, seen when coloured ice was employed in the experiments.

At one of the recent meetings of the French Academy of Sciences, M. de Verguette Lamotte made a communication on the effects of heat in the preservation and improvement of wines. Burgundy is well known to be much improved by a voyage to and from Calcutta. This fact led the author to try the effects of warmth on wines at home, and both he and M. Pasteur have come to the conclusion that wines may be much improved by gently warming them, and that sick wines may be cured by the same means. M. Pasteur has, in fact, taken out a patent for warming wines by placing the bottles in a hot-air stove with the corks tied down to prevent their being forced out by the expansion. The bottles must be quite full, and have no air in them, and are heated to 64° C. for half-an-hour, after which the cork is untied, driven home, and sealed down. In the process just described of course all parasitic ferments are destroyed, and the wines keep well after it.

Our readers are already acquainted with some of the ingenious propositions of M. Tellier to utilize the force evolved in the passage of liquefied ammoniacal gas from the liquid to the gaseous state, and its condensation again by contact with water. He has now proposed some further applications of liquid ammonia. These applications are founded upon two indisputable truths:—1. In empty spaces liquids spontaneously give off vapour, the tension of which immediately reaches its maximum. 2. In two spaces communicating, kept at equal temperatures, and containing one liquid, there is always evaporation in the warmer space and condensation in the colder. The first application suggested is a means of cooling the air of the saloon and cabins of a steamer, say, going down the Red Sea, where the want of cool air is generally experienced. For this purpose he puts liquid ammonia in a sort of tubular boiler, the tubes of which are in free communication with the air and the saloon to be cooled, while the boiler itself is in communication with a worm and receiver bathed with a stream of cold water. The warm air, as it passes through the tubes, parts with its caloric to vapourize the ammonia, and so reaches the cabin delightfully cool, while the ammonia goes on to the receiver to be again condensed. On its way it is utilized to drive a ventilator, supply cold water to the receiver, and pump itself back again to the generator; but by what contrivances and machinery is not stated. A modification of the same plan, as M. Tellier states, is also adapted to cool theatres and other places of entertainment, as well as ships' cabins. More ingenious still is the idea of making the solar rays volatilize ammonia, and so in parching heats manœuvre a pump or pumps which shall irrigate the thirsty earth with refreshing streams, and so make the sun partially undo its own work. More practicable, perhaps, is the idea of using the liquid ammonia to cool the wort in breweries and maintain a constant temperature during fermentation. Remembering that all these ends are to be effected without loss of material, we must give M. Tellier the credit of being one of the greatest inventors or most ingenious theorists of modern times.

A very useful contrivance has been described by Erlenmeyer for managing the application of heat in the distillation of liquids with high-boiling points. A sand-bath is very inconvenient, and a clay-coated retort is often out of the question. The Doctor therefore suggests surrounding the retort with short fibres of asbestos, which he keeps in their place by means of a wire gauze. Such an asbestos bath appears very simple, and will no doubt be perfectly efficacious.

Electricity.—M. Matteucci has studied the battery recently introduced by M. Blanc, who employs a plate of zinc and a plate of lead covered with a very thin deposit of copper, which are placed in a solution of common salt, with which is mixed a quantity of flowers of sulphur. This battery appears to be very useful for telegraphic purposes, and the only objection to its use is the evolution of some sulphuretted hydrogen, which would seem to be unavoidable. In the course of his experiments, the author arrived at the following conclusions:—1. That finely-divided sulphur in contact with the electro-negative metal of a pile formed of zinc, copper, and solution of common salt notably increased the electro-motive force, constancy, and permanency of the battery, and he hopes to obtain by the use of sulphur a voltaic combination possessing many advantages over the batteries at present employed. 2. Sulphur, although insoluble and an insulator, enters into combination with the sodium set free by the current. It remains for the author to explain the action of the small quantity of sulphide of copper which is formed, and which appears to be essential. For this end he has undertaken further experiments.

In a note presented to the Academy of Sciences in May last, M. de la Rive mentioned that a piece of crown or heavy flint glass through which a discharge from a large Rhumkorff is passed, undergoes a permanent molecular modification in its whole extent, losing almost entirely its rotatory magnetic power, and acquiring the properties of a crystalline body, or glass suddenly cooled.

A very interesting paper by M. Morren is given in the March Number of the 'Annales de Chimie et de Physique,' "On the Phosphoresence of Rarefied Gas during the Passage of the Electric Spark." The author endeavoured to discover the cause of the milky-white fog seen in some of Geissler's tribes. It has been attributed by many to the presence of oxygen; but this idea M. Morren shows is incorrect. He finds, in fact, that pure and dry oxygen, however much rarefied, is never phosphorescent; and, indeed, that no gas, simple or compound, is phosphorescent by itself. A mixture of oxygen and nitrogen, with 37 of nitrogen to 100 of oxygen, is feebly phosphorescent; but the phenomenon becomes much more visible when a little vapour of nitric acid is added to the mixture. But it becomes magnificent and lasting when to the preceding mixture a drop of Nordhausen acid or a little vapour of sulphuric acid is added. The same result may be obtained by passing the spark through a rarefied mixture of the following gases:—

Oxygen	500
Nitrogen	200
Sulphurous acid	300
Or,	
Very dry atmospheric air	100
Oxygen	30

And a little Nordhausen or anhydrous sulphuric acid. Other acids besides sulphuric will produce similar results—nitric and carbonic, for example; and the author shows the probability of being able to combine these gases with NO_3. He states that it is possible to form directly the compound $NO_3 2SO_3$ by the spark in convenient apparatus.

A note has been read at one of the late meetings of the Académie des Sciences, by M. De la Rive, "On the Conduction of Electricity by Metallic Vapours." These, the author shows, have the same or nearly the same conducting power as the metals in the solid state. The metals were vapourized by the voltaic arc, and on endeavouring to produce the arc with points made of various alloys, the author observed that the alloy was always decomposed. To observe this phenomenon better, he employed a plate of coke for a negative electrode, and the alloy for the positive, and then was able to collect the two metals which deposited separately on the coke.

At the meeting of the Academy of Sciences, held April 17th, M. E. Martin presented a memoir, entitled "An Electro-chemical Study of real Simple Bodies, Ponderable and Imponderable, divided into Two Classes by Peculiar Affinities." The author has arrived at a new science of electro-chemistry, based on the following assumptions, or, as he regards them, proved facts:—1. That the two electricities are not forces, but simple material bodies endowed with chemical properties, by virtue of which they form compounds with simple ponderable bodies. 2. That the two electric fluids of the battery are not produced by any physical action, but by a chemical action of the ponderable bodies which hold them in combination, and which, by uniting with each other, set the electricities at liberty. 3. That these same electricities collected by conductors, and transmitted in currents, participate directly in the actions they produce, and combine chemically with the elements they disunite. We may quote the decomposition and composition of water as an illustration of the author's views. Negative electricity he distinguishes as *electrile*, and gives it the symbol El; positive electricity is *etherile*, symbol Et. The formula of hydrogen becomes, therefore, HEl, and that of oxygen OEt. The two electricities arriving at opposite poles, attracts in the decomposition each its proper element, and we have

$$\mathrm{HO} + \mathrm{El} + \mathrm{Et} = \mathrm{HEl} + \mathrm{OEt}.$$

The two electricities in uniting with each other produce caloric, symbol C*, and light, L*. Here, then, are the essential principles of electro-chemistry: two electricities possessing peculiar and invariable affinities which unite with each other to form two *imponderable compounds*, heat and light, and with simple ponderable bodies also endowed with peculiar affinities of two kinds. We have thus two classes of bodies:—1. *Oxic*, which includes electrile, an imponderable body, and six ponderable elements, oxygen, fluorine, chlorine, iodine, bromine, and nitrogen; 2. *Basic*, which includes etherile, a simple imponderable body, the basic metalloids, hydrogen, carbon, boron, phosphorus, sulphur, selenium, and silicium, and all the metals. The author concludes—until now chemists have only recognized the effects of chemical union, but have never before discovered the cause—now the cause is manifest; bodies of the same kind are indifferent to each other, but they unite themselves with all bodies of the opposite kind, and the fundamental law of chemical union thus rests upon the duality of the kinds of simple bodies.

At a subsequent meeting of the *Académie*, M. Martin contributed the second part of his memoir, which he devotes to an explanation of the phenomena of combustion, and of the pile. The simplest case of combustion, according to the author, is that of a mixture of hydrogen and oxygen, which produce water and heat, and which, according to the above theory, is explained by the following equation:—

$$\mathrm{HEl} + \mathrm{OEt} = \mathrm{C}^*.$$

The two imponderables combine to form caloric, which is produced with sufficient intensity to become luminous before it combines with the water. Carbon hold two atoms of electrile, is C,El_2. When it is once burnt in oxygen, it forms carbonic oxide CO,El; burnt a second time with the same quantity of oxygen, it becomes CO_2, in which the two atoms of electrile are replaced by two atoms of oxygen. So with sulphur and the metals.

The action of the battery is a modified combustion in which the two imponderables are kept apart, and sent along different wires.

A most important paper on a new Thermo element is given by M. S. Marcus, in the 'Transactions of the Vienna Academy.' It is also printed in the 'Philosophical Magazine,' No. 197. Bismuth and Antimony are not used in these elements, but in their stead are taken different alloys, the proportions of which are given in the original paper. A powerful thermo-pile was constructed with a view to being used with a gas-flame. The individual elements consist of bars of unequal dimensions. The positive electrical bar is 7″ long, 7″ broad, and ½‴ thick; the negative electrical bar is 6″ long, 7″ broad, and 6‴ thick. Thirty-two such elements were screwed together, so that all positive bars were upon one, and all negative on the other side, and thus had the form of a grating. The battery consists of two such gratings, which are screwed together in a roof shape, and are strengthened by an iron bar. As an insulator between the iron bar and the elements, mica was used. Besides this, the elements, where they came into contact with the cooling water, were coated with soluble glass. An earthen vessel filled with water was used for cooling the lower contact sides of the elements. The entire battery has a length of 2 feet, a breadth of 6 inches, and a height of 6 inches.

M. Marcus communicated further that he had constructed a furnace which was intended for 768 elements. They represent a Bunsen's zinc carbon battery of thirty elements, and consume per diem 240 lbs. of coal.

The following are the properties of the combination:—

1. The electro-motive force of one of the new elements is $\frac{1}{25}$th of that of Bunsen's element, and its resistance is equal to 0·4 of a metre of normal wire.

2. Six such elements can decompose acidulated water.

3. A battery of 125 elements disengaged in a minute 25 cubic centimetres of detonating gas. The decomposition took place under

unfavourable circumstances, for the internal resistance was far greater than that of the interposed voltameter.

4. A platinum wire half a millimetre in thickness introduced into the circuit of the same wire is melted.

5. Thirty elements produce an electro-magnet of 150 lbs. lifting force.

6. The current is produced by heating one of the junctions of the elements, and cooling the second by water of the ordinary temperature.

X. ZOOLOGY.

Including Animal Physiology, the Microscope, and the Transactions of the Zoological Society of London.

Professor Gorini, of Lodi, near Turin, has been engaged for many years past in perfecting a process for preserving dead animals from putrefaction. His preparations of the human body have for some time been so excellent as to look like wax, the lips retaining their natural colour, and the expression being scarcely altered. For the purposes of dissection this method is likely to be of great practical value, as bodies can be retained in a state of softness and freshness for six months. After this time the preparations begin to turn hard and to assume a mummy-like aspect, but immersion in water restores them to their original softness. As yet M. Gorini has kept secret his process of preservation, but it is hoped that in the interests of science he will soon make it public. The process does not seem to be tedious or expensive, for he takes only one day in preparing subjects for future dissection, and for this operation he charges but four shillings. A commission of the Royal Academy of Sciences at Turin reported upon this process at the close of last year, from which report these details are derived. It is not only applicable for anatomical purposes, but can also be employed to preserve specimens of natural history, and to keep butchers' meat from change.

M. Dareste has investigated the facts relating to the coexistence of two embryos upon a single vitellus, first noticed by Wolff, and found that two distinct physiological phenomena are indicated. In the one case the distinct blastoderms are separated from each other in the earliest days of incubation, each presenting its transparent area, which may give rise to an embryo each enveloped in its proper amnios. These two embryos thus remain completely separated, being only mediately united by the vitellus. But in the second case there exists only a single blastoderm, and in this a single transparent area, which is remarkably irregular. The two embryos which are developed in this single, but irregular, area give origin to a single vascular area, and they become united by a single amnios. The two embryos thus developed upon a common transparent area remain in some cases completely isolated, except as regards their indirect union by the vitellus. These both may be developed normally, or sometimes one of them is imperfectly developed and forms an acephalous monster. In other cases, the two embryos unite directly and produce a double monster. These two modes of coexistence of two embryos upon a single vitellus evidently arise from the fact that in the first case the egg contains two distinct cicatriculæ before incubation; in the second, only one. A double monstrosity, therefore, is not, as was supposed, the result of the fusion of two embryos developed upon distinct vitelli; and M. Dareste maintains that for the formation of a double monster, the embryos must actually originate upon a single transparent area, that is, in a blastoderm proceeding from a single cicatricula. But it remains to be seen why in some cases the two embryos are separately developed, and in others they form a double monster. Another important question arises,—is this single cicatricula, which gives origin sometimes to two distinct embryos, and sometimes to two united ones, really simple, and similar to the ordinary cicatricula; or is it the result of the early fusion of two primarily distinct germs? Since M. Balbiani has shown how the germ is formed in the ovule, we may consider whether certain ovules may not contain a cicatricula apparently simple, but formed by the fusion of two originally distinct germs. And the coexistence of two germs within a single ovule is proved by the coexistence of two separate cicatriculæ upon the same vitellus.

Professor Owen has communicated to the Royal Society an account of the female Echidna (Echidna hystrix) with a young one, received from Dr. Müller, of the Botanic Gardens, Melbourne, in 1865. The young adhered to its mother as was supposed by a nipple. In the parent, Professor Owen found two marsupial pouches, about 1½ inch apart, each with the aperture longitudinal, half-an-inch in depth, and two-thirds of an inch in length. The young Echidna, about one inch in length in a straight line, could be received in a bent position into the pouch, and might cling to the fine hairs of that part by its claws; but there was no trace of a nipple. Each mammary gland terminates by numerous ducts upon the fundus of the corresponding pouch. The author concludes, from the appearance of the uterus and appendages, that this Echidna had produced two young, of which only one was secured, and that probably she had a mammary fœtus in each pouch at the time of capture. The young resembled the young of ornithorhynchus in general shape and curvature of the body, and also the new-born young of the kangaroo in the proportions of the limbs to the body, in the inferior size of the hind pair, and in the feeble indication of eyes and eyelids. The traces of ears, however, are less, the conch being little, if at all, developed in the mature Echidna. The form of the mouth is a transverse slit, and is a good monotrematous character of the young at that period, since in all true or teated marsupials, the mouth of the mammary fœtus has a peculiar circular and tubular shape. A scarcely visible linear cicatrix at the middle of the lower part of the abdomen is the sole trace of umbilicus. There are, however, still points in the generative economy of the monotremes which remain to be determined by actual observation, *viz.* the manner and season of copulation, the period of gestation, the nature and succession of temporary structure for the nourishment and respiration of the fœtus prior to birth—the size, condition, and powers of the young at the time of exclusion,—the period during which it requires lacteal nourishment,—and the age at which the animal attains full size.

The Rev. Dr. Haughton, of Dublin, has carefully dissected the leg of the ostrich, with a view to determine the peculiar muscular mechanism by which the limb, which may be regarded as a long rod bent at four distinct points, attains its greatest amount of shortening or bending at the moment the foot touches the ground, and is suddenly straightened or elongated by the simultaneous contraction of all the muscles; the effect of which is to throw the whole body of the bird forward from the point of support of the foot as if from a catapult. It is the two-bellied rectus muscle of the thigh which is the key to this remarkable action, which muscle binds down the patellæ, straps up the heel, and brings the whole machine into harmony at the moment that the spring is about to take place. The movements of the ostrich are described by eye-witnesses as admirable, the bird springing from foot to foot in rapid motion, bending with the rapidity of lightning the foot as it left the ground, avoiding skilfully and without apparent effort the dangers of the rough soil. It is said that it almost touches the ground with its body alternately on each side in every successive spring, and leaps with ease over rocks and shrubs of moderate dimensions that lay in its path. The force expended in propelling the body of the ostrich forward is calculated by Dr. Haughton to be ten times the force employed in restoring the legs of the animal preparatory to its next spring, and the question how this force is to be applied suddenly without breaking or dislocating the leg is answered by the remarkable structure of the rectus, which, instead of terminating in the patellæ, passes by a tendon in a groove over and between them, and turning outwards and backwards into the calf of the leg becomes provided with a second muscular belly, which forms one of the portions of the flexor magnus digitorum, the conjoined tendon of which passes under the heel and terminates in the plantar surface of the toe.

Among the curiosities of the Zoological Gardens of late has been a King Penguin (Aptenodytes Pennantii), a bird which, though very common and abundant in its haunts, and very easily caught, has never before been brought alive into Europe. The reason of this appears to be that though they are frequently kept for a time on board ship, they invariably die for want of food, which it seems they generally refuse to take. The present bird was brought on board at the Falkland Islands, with a dozen others, all of which died from refusing food. This one being fatter than his companions survived longer, and being petted and played with by the sailors, was at length induced by them to swallow some fat and fish, and from that time was carefully fed, and brought home in pretty good condition. For some unknown reason, the bird continued to refuse to eat unless the food was actually placed in its mouth by the keeper, when it bolted it voraciously, and by unmistakable gestures asked for more. If a fish were placed on a chair close to its beak, the creature refused to notice it, but followed the keeper's hand with open mouth for another to be dropped down its throat. Equally strange was its conduct with regard to its native element, the water; for though there was a convenient pond in the enclosure where it was kept, it carefully avoided going into it, and if placed therein, it scuttled out again as soon as possible; yet it evidently likes water, for it enjoys being syringed amazingly, turning its head round, and stooping down so that each part in turn may be well bathed. The consequence of these unaccountable freaks on the part of the Penguin has been that he has at length died, after being but a short time in the gardens. The speculations of Mr. Wallace upon this bird, from a Darwinian point of view, are curious. He considers it a highly specialized form of seabird, which in the process of adaptation to an aquatic mode of life, has reached a stage parallel to that of seals among quadrupeds. Their affinities will, therefore, be general rather than special, since they have become isolated by the extinction of a long series of nearly allied predecessors. Were it not, indeed, that the duty of hatching their eggs and rearing their offspring obliges them to come on shore, the continued modifications of structure in accordance with the requirements of an aquatic life might have been carried still further, and have produced a creature as fish-like among birds, as the whales and dolphins are among mammals.

Professor Steenstrup has contributed a remarkable memoir on the migration of the upper eye of the Flounders across the head from the blind side to the eye side. Calling attention to the obliquity of the Pleuronectidæ, and the curious fact which accompanies their want of symmetry—*viz.* that both eyes are brought round to one side of the head—he remarks that a new system of equilibrium is established for Flounders, in which the dorsal and ventral instead of the lateral halves become symmetrical in outline, and are equipoised. In most of the Pleuronectidæ (Sole), the left is the blind side; but in some (Turbot) it is the right; in both, however, there sometimes occur "wrong Flounders." Besides these there is a group of *double* Flounders, in which the sides are nearly equally developed and coloured, and the eyes placed, one in its ordinary position, and one on the top of the head; these swim vertically. In ordinary Flounders the eyes are not placed in a straight line, one above the other, but the upper eye is somewhat behind or before the lower, usually behind; and between them there stretches a firm, bony partition, formed of definite cranial bones. In the bony cranium there is a single orbit, entirely surrounded by bone, containing the upper eye only; the lower eye lies outside the orbit, and is protected above by the bones which form its lower margin, which are always found to be the frontals and prefrontals belonging to the eye side, and as the lower eye lies under these, it is evident that it is the usual position with reference to the forehead of its own side. And he infers that the eye of the blind side has come round to the (inner) side of the frontal bones of the blind side, which is turned towards the middle line, instead of lying at the outer (now up-turned) side. The old explanation, that the abnormal position of the Flounder's eyes is due simply to a greater or lesser degree of torsion of the whole head upon the axis of the body, or of a part of the head upon the axis of the head, is insufficient; for, notwithstanding, all the varieties in position, the relations of the upper eye to the surrounding bones of the head remain the same in all forms. This passage of the eye obliquely up through the head has, moreover, been proved by direct observations upon young Flounders. Minute pellucid specimens from the Mediterranean have been described by Rafinesque and Risso, and specimens have lately come under Steenstrup's notice from the Atlantic, about an inch long, having the eyes on the left side, and with them were other small fishes, resembling them in all particulars, save in this—that they were apparently quite symmetrical, with an eye on each side of the head. They were Flounders in an earlier stage. Perfect transitional forms have been noticed, giving "expressive evidence that the eye actually goes from one side up through the head over to the other side—in other words, that the symmetrical (young) fish by degrees squints its eye in and up through the head, out to the other side, and finally squints itself into a perfect Flounder."

The French Museum of Natural History has recently been fortunate enough to succeed in the reproduction of the Mexican Axolotls, which had never before been accomplished in Europe. The Museum possesses in the reptile department six of these animals, five males and one female. The eggs, spawned in the usual manner, consisted, like those of all Batrachians, of a black vitelline sphere, placed in the centre of a transparent vitelline membrane, which was again surrounded by a larger albuminous envelope. Nearly all the eggs were fruitful, and the hatching took place from twenty-eight to thirty days after they were laid. Soon after the egg was quitted, an important change occurred; the buccal cleft opened itself, and the animal fed with avidity upon the animacules floating in the water; in consequence of this, the stomach, which could hardly be recognized in the embryo, now became by degrees quite apparent. M. Dumeril is still engaged in observing the further development of these animals.

The reptiles in the Museum are very interesting generally. The 'Courrier des Sciences' states that in spite of croup, which seems to be the malady *par excellence* of the serpent tribe, there are still living a black trigonocephalus, acquired in 1842; and a tree-frog and fresh-water tortoise, dating from 1846 and 1847 respectively. Eight pythons, which measured on leaving the egg four years ago from ·45 to ·5 metre, have now acquired lengths varying from 2·5 to 3·3 metres; and a South American crocodile, which in 1857 was ·3 metre in length, now measures 1½ metre.

In order to encourage the study of Economic Entomology, the Council of the Entomological Society has announced that it has decided to offer two prizes of the value of five guineas each, to be awarded to the authors of memoirs of sufficient merit, and drawn up from personal observation, on the anatomy, economy, or habits of any insect, or group of insects, especially serviceable or obnoxious to mankind. The memoirs should be illustrated by figures of the insects in their different states, and if the species be noxious, they must show the results of actual experiments made for the prevention of their attacks, or the destruction of the insects themselves. The memoirs must be sent to the Secretary, No. 12, Bedford Row, London, with mottoes, on or before 31st December, 1865, when they will be referred to a committee to decide upon their merits. The prize memoirs shall be the property of, and will be published by, the Society.

A statement of the number of insects in the National Collection may not be uninteresting. The entomological department of the British Museum, we learn from the 'Reader,' contains 130 cabinets, 3,755 drawers, and 121 store boxes, the number of specimens being not less than 904,605. This wealth of species is unequalled in the museums of Europe; but it is rendered almost wholly unproductive of benefits to science from the want of able assistance to place it in order, since there is but one assistant employed in the supervision of the entomological department.

Some observations upon Crustacea have been made by Dr. Fritz Müller, for the purpose of testing the Darwinian hypothesis, on the principle of genealogical classification. Having constructed such a genealogical tree for the Crustacea, he has deduced certain necessary consequences, which if not verified by facts would be a fatal blow to Darwinism; but which, if they proved true, would furnish a strong presumption in favour of the theory. Hitherto his deductions have been verified. Thus in each family of crabs, we find as exceptions to the normal mode of life, certain terrestrial species. It is permissible to suppose *à priori* that these must present certain modifications of the respiratory apparatus to enable them to respire air, and that a multitude of arrangements may be capable of leading to this result. If he found in the terrestrial species of different families the same arrangements for affecting aërial respiration, the Darwinian theory would be irrevocably condemned; but if he should discover differences so complete as not to be reducible to the same type, this would certainly furnish a strong argument in favour of the theory; and the latter alternative has proved to be the true one. The three groups of Crustacea—*viz.* the stalk-eyed, sessile-eyed, and entomostraca—present essentially different modes of development. Darwin's theory, by assigning a common ancestor to all these Crustacea, presupposes that the ancestor itself presented these different modes of development. This hypothesis appears a bold one, and it has been reserved for Dr. Müller to demonstrate its truth, by the discovery of species with a mixed development, presenting the characters of the different groups. The most remarkable of these is a macrourous genus *Peneus*, which quits its egg, not under the form of a Zöea, but under that of a true *Nauplius*, perfectly similar to those of the Entomostraca. The integuments of the Nauplius are then cast off and a true Zöea issues from it, and this Zöea-phase afterwards gives place to one which can only be called a *Mysis*-phase. Finally, a last moult converts this pseudo-Mysis into a true Peneus; nor is this singular mode of development an isolated fact. The sessile-eyed Crustacea (Amphipods and Isopods), should, according to the Darwinian theory, have passed through a *Nauplius*-phase, or, at least, a *Zöea*-phase, although these phases are wanting in the existing species of which we know the development. Dr. Müller, however, has discovered that the Isopoda of the genus *Tanais* still retain the characters of incontestable Zöea.

A new kind of dimorphism has been remarked by Müller in the males of a species of Tanais. In this species, the individuals of which live together in myriads, the young males closely resemble the females. But the last moult gives rise to two very distinct forms of males. Some of these are furnished with enormous elongated and very mobile nippers, and with antennæ of as many as twelve or even seventeen olfactory filaments, of which the antennæ of the female do not exhibit one. The others retain short and heavy pincers, very similar to those of the females, but their antennæ have incomparably more numerous filaments than those of the first form of males. Müller regards these as two varieties of males, each of which in their way had been selected by peculiar and different advantages adapted to guide them in the search for females, and that therefore this singular fact is not inconsistent with the Darwinian hypothesis.

A remarkable instance of gemmation in an Annelid has been observed by M. L. Vaillant. The animal was a Syllidian from the Gulf of Suez, inhabiting the cavity of a sponge. The segment which bears the leaf-like processes was much broader than the rest of the body, and formed a sort of cup or funnel, representing two thick lips, of which the lower was smooth and simple, whilst the upper one was covered with an immense number of buds placed very close together, and having a very remarkable form, resembling that of some low forms of Annelids allied to Nemertes or Planaria. They had a very contractile body, nearly equal in length to that of the parent animal, flattened and obtuse at the free extremity, where they presented two or four small black eye-like spots. Towards the point of attachment the body became narrowed into an elongated pedicle, and if this were broken, the little creature moved freely in the water by movements of the body, but no vibratile apparatus could be detected. M. Vaillant says these bodies could not be parasites on account of the continuity of their tissue with those of the parent animal, and he does not think they can be regarded as oculiferous tentacles, because great mobility of the eyes occurs only where those organs are very few in number.

In 'Silliman's Journal' it is stated that starfishes may be dried so as to retain their natural colours almost unimpaired, by immersing them in alcohol of moderate strength for about a minute, or just long enough to destroy life and produce contraction of the tissues, and afterwards drying them rapidly by artificial heat, which is best effected by placing them upon an open cloth stretched tightly upon a frame, and supported a few feet above a stove. Care should be taken not to raise the heat too high, as the green shades change to red at a temperature near that of boiling water. The same process is equally applicable to Echini and Crustacea.

Dr. Child, in continuation of his experiments upon the production of organisms in closed vessels, has come to the conclusion that there is no doubt of the fact that *bacteria* can be produced in hermeticallysealed vessels containing an infusion of organic matter, whether animal or vegetable, though supplied only with air which has passed through a red-hot tube, and though the infusion be thoroughly boiled. The germs of bacterium must therefore be either capable of resisting the boiling temperature of a fluid, or they are spontaneously generated, or they are not organisms at all. With regard to the latter conclusion, although favourable to it at one time, Dr. Child is now convinced that they are really minute vegetable forms. If, however, it be true that *germs* are capable of resisting the boiling temperature of fluid, then both parties in the controversy are working on a false principle, and neither M. Pouchet nor M. Pasteur is likely at present to solve the question of spontaneous generation. In truth, if M. Pasteur's facts are incorrect, the whole question is relegated to the domain of what the French Academy Commission calls "pure discussion," and the one point which Dr. Child claims to have established is precisely that M. Pasteur's facts are inexact; not because his experiments were not most admirably performed, but simply because the magnifying power of his microscope was insufficient for the work to which he applied it. Dr. Child evidently leans to the doctrine of spontaneous generation, and remarks, that the objection, that in exact proportion as our observation of the higher forms of life becomes more exact, we are gradually driven from them to take refuge in the lower forms which we are almost or altogether unable to observe, has little force, since it might be expected that if any forms are generated spontaneously, they will be the very simplest and earliest in the scale of existence, which would be produced under the disadvantageous circumstances in which they must be placed. Dr. Child speaks highly of Powell and Lealand's fiftieth objective, which, he says, has already shown something like an appearance of structure in these minute *bacteria*, which leaves no doubt about their organic character.

A new periodical of much promise has just appeared in German, called 'Archives of Microscopic Anatomy,' conducted by Max Schultze, of Bonn, and published by Max Cohen and Son of that town. It is to be a quarterly journal, illustrated with about thirty plates annually, and each part will cost two thalers subscription. The contents will be original papers upon the Microscopic Anatomy of Man, Animals, and Plants, both Physiological and Pathological, as well as information upon the Microscope itself, and whatever relates thereto.

Professor Agassiz and a party have left New York on the way to South America, on an exploring expedition. His chief object is to make extensive collections in Zoology, and observations in other natural sciences. The expenses of the trip will be defrayed by Mr. Thayer, of Boston, who has most liberally placed his funds at the discretion of the Harvard professor; while the preparations, purchase of instruments, &c., have been at the expense of the Massachusetts Museum of Comparative Zoology, which is to receive the specimens brought home. Very important and interesting results are expected from this expedition, which will probably be absent at least a year.

Mr. R. B. N. Walker, a long resident on the Gaboon, whence he lately brought a remarkable collection of gorilla skins and skeletons, is about to make an expedition into West Tropical Africa, for the purpose of collecting animals, and for geographical discovery. His hunting-ground will be those little-known regions lying within seven or eight degrees on either side of the Equator, where he will specially occupy himself in search after a lake supposed to be there existent. Mr. Walker may be expected to learn something of the gorilla also, which he says is not nearly so rare as represented by M. du Chaillu, being found in the Dahomey country, and in nearly all the country between that and Congo, as well as being common in the Gaboon and Camma country, where it is sometimes found within three or four miles of the sea. The Royal Geographical Society has agreed to furnish Mr. Walker with the necessary instruments.

The deaths of three eminent Zoologists have been announced during the last quarter. Valenciennes, the celebrated ichthyologist, for many years the *collaborateur* of Cuvier, and the friend of Humboldt, has just succumbed to a long and dangerous illness. William Sharp MacLeay, author of 'Horæ Entomologicæ,' also died at Melbourne on 25th March last. The speculations of this celebrated work have been pushed to extremes by his successors, under the names of the "circular system," "quinarianism," &c., so that they became by-words, and the work of one of the most thoughtful and original of English biologists sank into the most unmerited neglect. Mr. MacLeay cooperated actively and earnestly with his friend, the late Mr. Vigors, in founding what is now one of the most important and flourishing of our scientific bodies, the Zoological Society of London; and also largely contributed to the establishment of the Australian Museum of his adopted country. He subsequently published a work called 'Annulosa Javanica,' besides contributing largely to the scientific periodicals; but since his departure to Australia but little has appeared from his pen. Another eminent Zoologist, and remarkable character, whose death has lately been announced, was Mr. Charles Waterton, of Walton Hall, the author of 'Wanderings in South America.' Mr. Waterton was a simple and earnest naturalist, who has spent more days and weeks and months in the woods than almost any man living, and whose remarkable experiences almost passed the bounds of credit—a circumstance which led to expressions from his reviewers which hurt him greatly. A devoted lover of animals, he formed his park at Walton Hall, near Wakefield, into a perfect paradise for birds and quadrupeds, who were all strictly protected; and his remarkable success in preserving them after death, of illustrations of which his house was well filled, rendered a visit to Walton Hall one of the greatest interest to the lover of Nature. Added to this, the simple and original character of the aged host was itself a study. Mr. Waterton was a stanch Catholic, and was upwards of eighty years of age, hale and hearty. An accidental fall, however, from a rustic bridge in his grounds, produced injuries from which he did not recover.

THE MICROSCOPE.

Dr. Beale has described to the Royal Society a new object-glass, with a magnifying power double that of a twenty-fifth. This is a *fiftieth*, and magnifies nearly three thousand diameters with the low eye-pieces. Messrs. Powell and Lealand, the makers, produced a sixteenth in 1840, and a twenty-sixth in 1860. The fiftieth defines even better than the twenty-fifth, which is now made instead of the twenty-sixth. Plenty of light for illuminating the object to be examined is obtained by the use of a condenser provided with a thin cap, having an opening not more than the thirtieth of an inch in diameter. The preparation may be covered with the thinnest glass made by Chance, of Birmingham, or with mica, and there is plenty of room for focussing to the lower surface of thin specimens which can alone be examined by high powers as transparent objects. Particles too transparent to be observed by a twenty-fifth are distinctly demonstrated by the fiftieth; and Dr. Beale is of opinion that by the aid of those high powers the further careful study of the development and increase of some of the lowest organisms, and the movements which have been seen to occur in connection with certain forms of living matter, as Amœba, white-blood corpuscles, young epithelial cells, &c., will lead to most valuable results. The finest nerve fibres ramifying in the cornea and in certain forms of connective tissue are also beautifully brought out by this power, and their relation to the delicate processes from the connective tissue corpuscles can be more satisfactorily demonstrated than with the twenty-fifth. The advantage of the fiftieth in such investigations seems mainly due to its remarkable power of penetration. The angular aperture of this glass is 150°. Many twelfths have been made with a higher angular aperture, amounting to 180°.

At the Microscopical Society Mr. Huggins has read a paper "On the Prismatic Examination of Microscopical Objects." The microscopists can hope to profit by prismatic analysis only in the case of those substances which modify the light by a special absorption either during transmission or reflexion. But the discoveries of Professor Stokes in connection with the optical character of blood and chlorophyll, show that even this restricted field of investigation is one of considerable promise. By means of the prismatic microscope, the spectrum of any part of a microscopic object can be examined apart, and also can be compared with the spectra of the adjoining parts of the same object. Thus the spectrum of a single blood disc or of the contents of a single cell can be observed, and changes in living tissues which cause a modification in the spectrum can be watched and investigated. Microscopic physiology may receive some aid from this way of using the prism, since the deepest object-glasses, even the fiftieth, may be employed. The spectra of the light reflected from different parts of the *opaque* object can be separately examined. The plan consists essentially in placing the slit of an ordinary spectrum apparatus in the position usually occupied by the eye-piece of the microscope. Behind the object-glass, at a distance of three or four inches, an adjustible slit is placed, and the object-glass is focussed upon the object, so that the magnified image shall fall precisely upon the slit. The opening of the narrow slit allows the light of a small part only of the magnified image to pass on to the prisms. Mr. Wenham suggests that it would be convenient to adapt the spectrum apparatus to the direct tube of his binocular microscope, as then by looking into the other tube furnished with an eye-piece the particular part of the object under investigation with the spectroscope could be easily determined.

Mr. Bridgeman, of Norwich, proposes an improvement in the Lieberkühn for examining opaque objects with a binocular, which shall place the quantity, quality, and direction of light under complete control. It consists of covering up a portion of the reflecting surface of the Lieberkühn, so as to obtain any proportion of oblique light in one particular direction, and then by rotating the Lieberkühn upon the object-glass, it may be brought to bear upon every part successively without having to alter the position of the object. In this way the most delicate structure, as the barbs upon the nearly transparent spines of *Opuntia tunicata*, may be brought out into full and bold relief. The elegant arrangement of crystallized silver can scarcely be seen to advantage in any other way. He proposes to fix a triangular piece of thin, dull, black paper upon the silver with gum, and when dry to trim off the projecting parts from the centre and circumference with a sharp penknife, so as to give it a neat appearance. The tube of the Lieberkühn should move freely upon the object-glass, and be provided with a milled ring, so as to be easily rotated between the finger and thumb.

ZOOLOGICAL SOCIETY OF LONDON.

During the past quarter, the annual meeting of the Society has been held, and the Council's Report, with much interesting matter, shows that the Society is financially and otherwise in a state of great prosperity. There were nearly two thousand fellows and subscribers upon the roll, and the receipts from their subscriptions, added to that of visitors to the gardens, produced an income for 1864 of 21,713*l*., or 1,429*l*. in excess of the previous year. Upwards of half a million persons had visited the menagerie during the past year, a number exceeding that of any year except the Exhibition years of 1851 and 1862. The expenditure, ordinary and extraordinary, of the past year amounted to 24,889*l*., and the present state of the finances shows that, leaving out of account a reserve fund of 10,000*l*. 3 per Cents., which it is not contemplated to increase, there is still a balance available to be added to the receipts of the present year.

During the year 1864, extensive additions had been made to the buildings in the gardens, including entrance lodges, an aviary, and the new monkey-house. The total cost of the last amounted to 4,842*l*., but this expenditure would be well repaid by the increased attraction to the public, and the increased attention to the welfare and health of the Quadrumana contained in it. In striking contrast to the constant mortality that had prevailed in the old monkey-house, the deaths among them during the late long and severe winter had been very few, and the greater number of them had remained in a state of excellent health. In addition to a crowd of smaller Quadrumana, there is at present a red orang and a black chimpanzee in the house, both of which are well worthy of attention; and for the first time, these anthropoid apes have passed a winter without contracting cough or consumption. Moreover, the atmosphere of the house presents an agreeable contrast to that of the former small and confined building, in which it was impossible to remain for any length of time; and, doubtless, the present admirable structure will be greatly improved in process of time, as various suggestions offer themselves, so that when the long-desired gorilla arrives, there shall be no reason why he should not be long kept alive and in health. Last year, a most interesting series of rare quadrumana was obtained, among them were numerous spider monkeys and red howlers, and the rare Lagothrix Humboldtii, which died most probably from insufficient accommodation. The expenditure of so large a sum in a properly-constituted house is, therefore, true economy.

During the year 1864, there were exhibited for the first time eight mammals, including the orange-quilled porcupine (Hystrix Malabarica), twenty-three birds, including the tooth-billed pigeon (Didunculus strigirostris) of the Samoān Islands, supposed, until recently, to be quite extinct, as well as two reptiles and two fishes. There have also bred in the menagerie, during the year, twenty-two species of mammals, twenty species of birds, one reptile, and three fishes.

An important movement has also been made in the Society during the last quarter. The Council resolved to appoint a 'Prosector' in the gardens, at a salary of 250*l.* per annum, whose duty it should be to make dissections of the animals which die in the menagerie, and have not been promised elsewhere. If the Zootomical Committee shall have disposed of the skin, or skeleton, or both, an examination will be made to determine the cause of death, so far as it can be made without injury to the skin or skeleton,—and an accurate record will be kept of the dissections, or other anatomical or physiological work performed; and such parts of the record as may be approved by the Committee will be presented by the prosector to the Society, at its scientific meetings, for publication in the Proceedings or Transactions. For this desirable post, there were twenty-eight candidates, from whom the Council selected Dr. James Murie, of the University of Glasgow, formerly Pathologist to the Glasgow Infirmary, and afterwards Assistant in the Museum of the Royal College of Surgeons, Lincoln's-Inn-Fields. Dr. Murie left the College of Surgeons to join Consul Petherick's expedition to the White Nile, as naturalist, and there made extensive collections in natural history. The same gentleman has communicated a paper to the Society, in March last, upon the muscular system of the curious little Hyrax, or coney, which, being a pachydermatous animal, in so many points resembles the rodent type. Also papers "On the Anatomy of the Lemur, *Nycticebus tardigradus;*" "On the Sperm Whale," &c.

At the ordinary meeting of the Society, many interesting papers have been read. Mr. Sclater's communications pointed out the accessions to the menagerie, and incidents of interest which from time to time took place, such as the laying of eggs by the rarer birds. Not so many birds as usual appear to have fallen to the lot of Mr. Sclater for description, the chief being a new genus of Passerine birds from Madagascar, and a new species from British Guiana. Dr. Gray's papers have chiefly had reference, as usual, to mammals, and the porpoise, which lately died in the menagerie, afforded a text for an interesting communication. It was remarkable for having a row of tubercles on the upper margin of the dorsal fin. This structure did not appear to have been previously noticed in the common porpoise, although a species from South America, lately described by Dr. Burmeister, possessed it in a highly-developed degree. This latter species was taken alive at the mouth of the Rio de la Plata, and described by Burmeister as a new species, under the name of *Phocæna spinipinnis.* Further examination of the British specimen showed that it possessed a striking difference from the common porpoise in the shape of the occipital foramen, and has induced Dr. Gray to consider it as a new species, which he calls *P. tuberculifera.* A useful revision of the insectivorous Edentata has also been prepared by Dr. Gray from the specimens in the British Museum, amongst which he has found two species heretofore undescribed. A notice of a new species of porcupine from South America, and of a genus of tortoise from West Africa, are also among Dr. Gray's contributions.

Mr. E. S. Layard, a brother of the Under-secretary, resident at Cape Town, is from time to time adding new material to Zoological Science, and now sends accounts of two whales in the South African Museum, which Dr. Gray considers to be new species, and calls *Ziphius Layardii*, and *Hyperöodon capensis.* He also sends a description of a new zebra discovered by Mr. Chapman in the interior of S. W. Africa.

Professor Huxley has described his researches into the anatomy of bats, in the genus *Desmodus,* of which he has found a singular form of stomach, in which the cardiac end of this organ assumes the form of a greatly elongated cæcum reflexed upon itself. This character, added to peculiarities of dentition, seems to him to indicate the necessity of constituting this genus, with the allied form *Diphylla*, in a separate section of the Order of Bats.

The remarkable discovery of a preserved Dinornis, now in the York Museum, has given Mr. Dallas, the Curator, an opportunity of examining the feathers of that extinct bird. He has given a full description of their structure, and shows that the remnants of the large accessory plume attached to each feather manifests a near relationship between Dinornis, and the Emeus and Cassowaries. Mr. Newton exhibited and described a number of hitherto unknown, or little known, birds' eggs. Among them were those of the tooth-billed pigeon, the Opisthocomus, and the nutcracker, &c. He believed that the eggs of the nutcracker (*Nucifraga caryocatactes*) which had been obtained from the island of Bornholm, were the first really authentic examples which had reached this country.

Fishes have not been neglected, and a memoir of those of Cochin, on the Malabar coast of India, has been read by Mr. F. Day. This gentleman has obtained in this locality 210 species, of which about one-tenth were previously unknown. The indefatigable researches of Mr. J. Yate Johnson, in Madeira, have also been again rewarded by a new form of trichiuroid fishes, which he calls *Nealotus tripes.*

The land- and fresh-water shells of the Zambesi and Lake Nyassa have been the subject of a communication from Dr. Kirk. The land shells of the Malay Archipelago, collected by Mr. Wallace, have been described by him, in conjunction with Mr. H. Adams; and Dr. P. P. Carpenter has communicated three papers upon the shells of Panama, Mazatlan, and the West Tropical region of North America. In addition to these papers, interesting communications have also been read by Dr. Crisp, Dr. Murie, Dr. W. Peters, Dr. Hartlaub, and other eminent Zoologists.

XI. SCIENCE IN CANADA.

BOTANY.—*Filices.* In the 'Canadian Naturalist and Geologist' we find a Synopsis of Canadian ferns and filicoid plants, by George Lawson, Ph. D., LL.D., and a paper on the same subject, serving as a supplement to the former, by David R. McCord, B.A. The whole number of Canadian species that have been enumerated is seventy-four, of which eleven are doubtful. Of the sixty-three certainly known, fifty-eight are inhabitants of the Northern United States, thirty-eight of the Southern States, and thirty-six are found in Europe. Dr. Lawson gives a list of the seventy-four species, showing their occurrence in Canada, the Northern States, the Southern States, Europe, Continental and British, and within the Arctic Circle, respectively. The table is followed by a description of the species, with the localities where they have been observed. Mr. McCord's list contains additional localities in Lower Canada, those given by Dr. Lawson being chiefly Upper Canadian. Amongst well-known British ferns occurring in the Colony, we observe that Polypodium vulgare is common in Lower Canada, and widely distributed, though not very common, in Upper Canada. Pteris aquilina, Athyrium filix-fœmina, and Lastrea dilatata are common in both provinces; and Lastrea cristata, Woodsia Ilvensis, Osmunda regalis (represented by the var. β spectabilis), and Botrychium Lunaria, are not uncommon. Asplenium trichomanes, and Polystichum augulare are rare, whilst Scolopendrium vulgare, Asplenium viride, and Ophioglossum vulgatum have each been found in one locality only, the first in Upper Canada, the two latter in Lower Canada. On the other hand, we miss our British Aspidium Oreopteris, Lastræa filix-mas (recently, however, found on the Rocky Mountains), Asplenium adiantum-nigrum, and Blechnum boreale. Of the seventy-four species of filices described, six are peculiar (so far as is yet known) to Upper Canada. Five species, *viz.* Struthiopteris Germanica, Plananthus lucidulus, Lycopodium complanatum, Salvinia natans, and Equisetum scirpoides are common to Canada and to Continental Europe, but are not found in the British Islands. In speaking of Equisetum, Dr. Lawson remarks on the great value of E. limosum and of E. arvense as fodder plants; on the Western prairies, horses are said to get "rolling fat" on equisetum in ten days. With regard to the habitats of Canadian ferns, Mr. McCord remarks that more than half of the Lower Canadian ferns are inhabitants of moist tracts, being found either in open meadows or in swamps; the remainder grow upon rocks with little moisture, as Woodsia Ilvensis, Cystopteris fragilis (occasionally), and Allosorus gracilis; or upon rocky positions but requiring moisture, as Asplenium trichomanes: in the latter case they suffer during dry seasons.

Calluna vulgaris, the common British ling or heather, has been found in Cape Breton. It had previously been noticed in the south-east peninsula of Newfoundland, and in Massachusetts. These with Greenland (according to Giesecke) form the only known localities of this plant in America.

Geographical distribution of Canadian plants. Mr. A. T. Drummond, B.A., LL.B., contributes to the 'Canadian Naturalist' a valuable paper on Canadian Geographical Botany. He distributes the plants hitherto found, into five groups, excluding in his enumeration mosses, lichens, and lower forms. The groups are thus distinguished:—I. *Canadian type*—Species generally distributed through the whole or greater part of the province. *II. Erie type*—Species chiefly restricted to the district bordering Lake Erie. *III. Superior type*—Species only found about Lake Huron and Superior, and most of which have evidently migrated from the country watered by the Sashatchewan. IV. *Maritime type*—Species confined to the seashore. *V. Alpine type*—Species chiefly known, at present, to occur about the north-eastern borders of the province. The English botanist will be interested in observing the relation held by the various groups to the flora familiar to him; and we have therefore made a comparison between Mr. Drummond's lists and the accepted lists of British plants.

I. *Canadian type.*—The list includes fifty-two species belonging to forty-five genera. Of the genera thirty-eight are represented in Britain. Of the species twelve are British, *viz.* Ranunculus repens, Caltha palustris, Nasturtium palustre, Drosera rotundifolia, Lathyrus palustris, Epilobium angustifolium, Linnæa borealis, Menyanthes trifoliata, Equisetum sylvaticum, E. arvense, Polypodium vulgare, and Asplenium filix-fæmina. There are also the semi-British Impatiens fulva and Antennaria margaritacea. The natural orders best represented are Rosaceæ and Ericaceæ amongst the larger, and Coniferæ and Betulaceæ amongst the smaller orders.

II. *Erie type.*—Genera forty-two, species forty-eight, of which are British—genera seventeen, species, none. The forests bordering Lake Erie have abundance of beech (Fagus ferruginea), sugar-maple (Acer saccharinum), oak (Quercus rubra, Q. macrocarpa, and Q. alba), and walnut (Juglans nigra). The flora of this district resembles that of the western part of New York State.

III. *Superior type.*—Amongst the species of this district, Mr. Drummond mentions thirty-seven, belonging to thirty-two genera. Twenty-six of the genera are British, but only nine species, *viz.* Arabis petræa, Linum perenne, Matricaria inodora, Melampyrum pratense, Polemonium cæruleum, Humulus lupulus, Carex Vahlii, and Aspidium lonchitis. Some few species, which in the United States are north-western plants, reappear near the north-eastern Canadian boundary line. Thus Parnassia palustris, a species of Upper Michigan, the Lake Superior region, and north-westward, likewise occurs in Labrador and Newfoundland. Under the preceding types the lists given are representative, not complete. The next list includes all yet known.

IV. *Maritime type.*—Genera twenty-six, of which twenty-one are British; species twenty-eight, of which fourteen are British; *viz.* Honkenya peploides, Spergularia marina, Lathyrus maritimus, Ligusticum Scoticum, Plantago maritima, Armeria vulgaris, Glaux maritima, Mertensia maritima, Salicornia herbacea, Chenopodina maritima, Salsola Kali, Triglochin maritimum, T. palustre, and Juncus bulbosus. It is remarkable that many maritime species occur in the neighbourhood of the great lakes; thus, at least eight truly sea-shore plants have been found near Lake Superior. Many are also found inland near salt springs. It is suggested that these facts indicate the former partial submergence of the country, when the sea-shore was much farther inland than now.

V. *Alpine type.*—Of strictly Alpine character Mr. Drummond mentions twenty-nine species belonging to twenty-six genera. Twenty-three of the genera are British, including the following fourteen species:—Thalictrum alpinum, Draba incana, Viola palustris, Sibbaldia procumbens, Rubus arcticus, Epilobium Alpinum, Sedum Rhodiola, Saxifraga stellaris, S. nivalis, Erigeron acre, Arctostaphylos alpina, Betula nana, Salix reticulata, and S. repens.

The list of sub-Alpine species contains nineteen genera, of which sixteen are British; and twenty-two species, of which fourteen are British, *viz.* Rubus Chamæmorus, Solidago virgaurea, Vaccinum uliginosum, V. Vitis-Idæa, Euphrasia officinalis, Polygonum viviparum, Empetrum nigrum, Tofieldia palustris, Scirpus cæspitosus, Poa alpina, Phleum alpinum, Woodsia alpina, Asplenium viride, and Lycopodium Selago.

It is to be regretted that the names of the species in Mr. Drummond's lists are without the affix indicating their authority. In the present day, when descriptive natural history is crowded with synonyms, and when scarcely two naturalists agree in specific arrangement, a name cannot be considered definite, unless that of its originator is added.

Michaux.—The Abbé Ovide Brunet, professor of botany at the Laval University, Quebec, has collected sufficient materials to enable him to give for the first time a tolerably complete account of the travels of the botanist André Michaux, through Canada. His paper, of which a translation appears in the 'Canadian Naturalist,' is extremely interesting; and is rich in information concerning the distribution of plants throughout that part of the province round Lake St. John, and adjacent to Hudson's Bay. It also furnishes a good general description of the district, which is but little known. The lists of plants include many well-known British species, whilst the number of genera foreign to Britain is extremely small.

ENTOMOLOGY.—*Pieris rapæ.*—Mr. G. J. Bowles, Secretary to the Quebec branch of the Entomological Society of Canada, read a paper before the branch Society "On the Pieris rapæ (or Pontia rapæ)," which is the small white cabbage butterfly, common in England, where it is very destructive. He states that it is now present in considerable numbers within a radius of about forty miles round Quebec. It appears to have been first introduced into the province at that city about seven or eight years ago, being probably brought over amongst vegetable produce. Two males of a bright canary colour, a variety occasionally taken in England, have been captured. In the autumn of 1863, the ravages of the larvæ, in the vicinity of Quebec, were very great. Several specimens collected by Mr. Bowles showed that they are attacked by a parasite, probably one of the Ichneumonidæ. (This is also the case in Britain.) Mr. Bowles describes the insects in order that farmers and gardeners may recognize and destroy them.

Entomological Society of Canada.—This Society has resolved to prepare and publish catalogues of all the known Canadian insects; commencing with the Coleoptera and Lepidoptera. This is an example well worthy of imitation by all local and provincial Natural History Societies.

Attacus polyphemus.—In August, 1863, Mr. Wm. Couper, of Quebec, found two caterpillars of this lepidopter feeding on sweet-briar, a plant said to be introduced into Canada. The food-plants previously ascribed to it, were the oak, elm, and lime trees. It has also been found on the maple; but as the larva is large, soft, thin-skinned, and hairless, its occurrence on the thorny briar is remarkable. Mr. Couper kept the two specimens in confinement on this plant, until they commenced spinning, previously to which, they ejected the contents of the viscera, consisting of about a teaspoonful of a dark green fluid.

Gall of Triticum repens.—The same observer describes the occurrence on Triticum repens, Linn. (the creeping wheat-grass or couch-grass), of a gall produced by a hymenopterous insect of the genus Eurytoma (possibly E. fulvipes). The insect appears in June, when the female deposits an egg in each joint of the grass, producing a gall, which appears externally as a tumid part of the stem. As soon as the larva issues from the egg, it places its head downwards in the gall, remaining in that position until it eats its way through. During the winter, it remains torpid in the hardened gall, becoming active again in the following spring, and changing to the perfect insect in time to attack the young grass.

Geology and Palæontology.—*The Geology of the Ottawa Valley* has been described in a lecture delivered before the Ottawa Natural History Society, by Jas. A. Grant, M.D., F.R.C.S.E., F.G.S. The whole of the rocks beneath the drift are older than the grey sandstone of the New York series, which corresponds to the Llandovery beds or Middle Silurian of Britain (see 'Report of Geology of Canada, Murchison's Siluria,' chap. xviii., and 'Lyell's Elements of Geology,' 6th edition, p. 566). The lowest formation described (leaving out the metamorphic rocks) is the Potsdam sandstone, equivalent to the Upper Cambrian of Lyell, and to the lowest members of the Lower Silurian of the Geological Survey of Britain. It crosses from New York State into Canada, being well developed in the county of Beauharnois (see 'Lyell's Elements,' p. 577). Above this is the Calciferous Sand-Rock, which, in that part of Canada, is principally a granular magnesian limestone, with some imperfect fossils. Its thickness is about 300 feet. The Chazy limestone, next in the series is, in Canada, associated with sandstones and shale. It forms a zone around the Geological depression between the Ottawa and the St. Lawrence. Above this formation is a great mass of limestones, divided by the New York Geologists into three formations—the Bird's-eye limestone, the Black River limestone, and the Trenton limestone. In Canada, however, these divisions are indistinguishable, either lithologically or palæontologically, consequently they are united, and constitute the Trenton group, which forms, according to Sir W. Logan, one of the most persistent and conspicuously marked members of the Lower Silurian rocks of North America. It is found largely round the city of Ottawa. Its thickness is probably not less than 600 feet; but dislocations make the amount difficult to estimate. The next formation is the Utica Slate, consisting of dark-brown bituminous shales, interstratified here and there with a few beds of dark limestone. In some places, the shale is sufficiently bituminous to produce mineral oil in considerable quantity. The drift formation extends over North America, north of the parallel 40°, and forms the surface of country over a great part of the triangular area included by the St. Lawrence and Ottawa rivers. It consists of stratified clays and sand, with erratic boulders, many of them of great size. The channel of the Ottawa is contracted in various places by ridges of drift. The post-glacial beds are divided by Dr. Dawson into two series, the lower being the Leda Clay, a deep-sea deposit; the upper, the Saxicava Sand, formed in shallow waters. Amongst the clay fossils are Saxicava rugosa, Tellina Greenlandica, and the Mallotus villosus or capeling of the lower St. Lawrence. [This is the little fish mentioned by Agassiz as the only tertiary species which he was able to identify with a living form. It is found in nodules of clay in Greenland. "These nodules exemplify the operation of the dissolving soft parts of the fish in consolidating the surrounding matrix," 'Owen's Palæontology,' 2nd edition, p. 174.] The same fossil is found in nodules, in clay at Fort Coulogne Lake, at 365 feet above the sea. Most of the boulders are composed of gneiss, either ordinary or hornblendic. [In connection with this subject, see an interesting paper by Professor Hind, of Toronto, on the "Drift of Labrador, &c.;" 'Quarterly Journal, Geological Society,' vol. xx., p. 122, May 1864; and 'Canadian Naturalist' for Aug., 1864.] Dr. Grant next describes the "rock-basins" or "pot-holes," which are everywhere common along rapid brooks and rivers, and are most frequently seen on elevated ground. Two of considerable dimensions occur near Ottawa, one being three feet in diameter and thirteen in depth, the other ten feet in diameter and fifteen to twenty in depth.

Geology of Eastern New York.—Dr. T. Sterry Hunt gives, in the 'Canadian Naturalist,' a short account of the results arrived at by Professor James Hall and Sir William E. Logan, in the examination of the rocks of Eastern New York, with the object of comparing them with Canadian formations. These gentlemen succeeded in recognizing the Sillery and Quebec groups in that region, and also in identifying the gneissic district of the Highlands of the Hudson with the Lawrentian system of Canada. This conclusion agrees with the observations of Professor Cook, and of Vanuxem and Keating, according to all of whom the gneiss and crystalline limestones of Orange County and of New Jersey underlie unconformably the Lower Silurian strata.

The Gold of Nova Scotia.—Mr. G. F. Hartt shows that, in Colchester County, N.S., auriferous clay-slates, similar to those of the other gold districts of the province, are overlaid unconformably by sandstone, grit, and conglomerate of Carboniferous, probably Lower Coal-measure, age. At the junction the conglomerate and grit are richly auriferous—the greater part of the gold mined in the locality being obtained from the conglomerate. The inference is drawn that the gold is of pre-Carboniferous age, both in that locality and elsewhere in the province.

Tracks and Feet of Trilobites.—At a meeting of the Canadian Natural History Society, held on September 26th, 1864, two interesting and important papers were read, bearing on the nature of Trilobites. The first was by Principal Dawson, on the genus *Rusophycus*. This genus was established by Professor Hall, for certain transversely wrinkled impressions found in the Clinton group and Chazy sandstone, and supposed to be fucoids. Mr. Billings thus describes the species found in the Chazy sandstone of Grenville:—"This species (R. Grenvillensis) is found in the form of irregular, oblong-ovate, or depressed hemispherical masses, one end usually divided into two parts by a furrow of more or less depth. The whole mass is generally crossed by numerous undulating wrinkles, which have a transverse direction to that of the furrow. The more common dimensions are from three to four inches in length, and from two and a-half to three and a-half in breadth, but occasionally specimens occur much larger and also smaller; one of them is nine and a-half inches by five and a-half, and, in addition to the principal groove, exhibits two or three obscure furrows on each side." Dr. Dawson adds that the longitudinal furrow is always more strongly marked at one extremity of the fossil, and that there is no indication of a stem or stalk. From an examination of the fossils *in situ*, Dr. Dawson concluded that they were casts of hollows or holes excavated in clay, and afterwards filled with sand.

The appearances can be explained on the supposition that some animal crawling on the soft mud at the bottom of shallow water, by means of feet which made a double series of transverse marks, was in the habit of excavating deep burrows for shelter or repose. The burrowing of the modern *Limulus* would produce a similar effect, with the addition, however, of the mark of the caudal spine, of which these fossils show no trace. Hence the animal required would be a crustacean, having feet and habits of life generally resembling those of *Limulus*, but without a caudal spine. Such were trilobites; and in particular the feet of *Asaphus*, as discovered by Mr. Billings, would appear to be precisely what would produce the markings. Dr. Dawson thinks it probable that the burrows were places of incubation, and that the tribolites carried their spawn attached to their swimming feet, and were in the habit of resorting to shallow water for the purpose of incubation. He proposes to change the generic name to *Rusichnites;* and he thinks it probable that the Grenville specimens may belong to three species of tribolites. Similar fossils from the Lower Carboniferous of Nova Scotia are named *R. Carbonarius.* Lastly a species from Cape Breton, called *R. Acadicus* (figured in the 'Canadian Naturalist' for December, 1864), seems to be the track of the swimming feet and edges of the carapace of a small *Limulus.*

The second paper was by Mr. Billings, "On a remarkable specimen of *Asaphus platycephalus.*" The author exhibited a specimen of this tribolite from the Trenton Limestone of Ottawa, which had been in part carefully extricated from the matrix. The specimen had eight thoracic segments, and exhibited on the under side eight semi-cylindrical ridges on each side of the median line, all curving outwards and forwards. Mr. Billings believed these to be the bases of attachment of eight pairs of swimming feet. Burmeister's supposition as to the nature of the legs of tribolites was fully borne out by this discovery, except that in Burmeister's sketch the limbs are directed backwards. The legs were probably thin and foliaceous.

Apatite (phosphate of lime), according to a paper by Dr. T. S. Hunt, occurs abundantly in several parts of Canada, as in the vicinity of Perth, and at several points along the Ottawa. It is found disseminated in small crystals through Lawrentian crystalline limestones, and in regular veins which intersect the rocks of the same system. In the latter case it is sometimes nearly pure; at other times it is associated with pyroxene, large crystals of magnesian mica (which are wrought), and other silicated minerals. Attempts are now being made to work the deposits of this mineral in North Burgess.

ZOOLOGY.—*Classification.*—An important paper by Dr. Dawson "On the Classification of Animals," appears in the 'Canadian Naturalist.' It is difficult in a few words to give a summary of the views of the author, but the following are some of the salient points:—First, with regard to species. The essential characters of a species are points of structure, proportion of parts, ornamentation and habits; but it is also necessary to take into account its continued existence in time, and we are therefore brought to the definition of species long ago proposed by

Cuvier and De Candolle, which unites in one species all those individuals which so resemble each other that we may reasonably infer that they have descended from a common ancestry. Such a definition is, for practical purposes, unaffected by the Darwinian hypothesis. The origin of the first individuals of a species may be, and probably is, a problem not within the province of natural history. Of vital force, and of creative force or power, we are ignorant. We know nothing, except by inference, of its laws, and we must always be obliged to pause at the line where what we call force resolves itself into the will of the supreme spiritual Power. The species is a natural, the genus an artificial group; they differ not in degree, but in kind. There are four distinct grounds on which comparisons may be made for purposes of classification. These are: 1st, intimate structural resemblance, used in forming *genera;* 2nd, grade or rank, as to complexity of structure or development of the highest functions, used for distinguishing *orders;* 3rd, use or function, referring to special development of the nervous, motive, nutritive, or reproductive function respectively, enabling us to group animals into *classes;* and 4th, plan or type, enabling the naturalist to mark the primary division of animals into *provinces.* Dr. Dawson adopts Cuvier's fourfold division into Vertebrata, Articulata, Mollusca, and Radiata, considering it to be by much the most natural and philosophical yet proposed. He regards as retrograde the attempts to introduce additional branches or provinces, such as the Protozoa of Siebold, the Cœlenterata of Leuckart, and the provinces Molluscoida and Annuloida of Huxley.

The following is his table of classes:—

Table of Classes of Animals.

Provinces or Branches.	Vertebrata.	Articulata.	Mollusca.	Radiata.
1. Nervous class.	*Mammalia.*	*Arachnida.*	*Cephalopoda.*	*Echinodermata*
2. Motive class.	*Aves.*	*Insecta.*	*Gasteropoda* (including *Pteropoda.*)	*Acalephæ.*
3. Nutritive class.	*Reptilia.*	*Crustacea.*	*Lamellibranchiate.*	*Anthozoa.*
4. Embryonic or Reproductive class.	*Pisces.*	*Annulata,*	*Molluscoida* (including *Tunicata, Brachiopoda,* and *Bryozoa*).	*Protozoa.*

XII. SCIENCE IN THE PROVINCES.

Local Museums and Provincial Societies.—It has of late been frequently insisted upon, that the main objects of the various Natural History Societies which exist throughout the country should always be the examination of the phenomena displayed in their immediate neighbourhood, that they should deal principally with local and, to a less extent with general, subjects. In like manner a local museum, it has been observed, should, above all things, include an assemblage of objects, representing, as completely as it is possible, the natural history, archæology, &c., of its own district. But a truth of this kind cannot be too often reiterated, nor too generally known; and we are therefore happy to find it well enunciated in a lecture delivered to the members of the Bath Natural History and Antiquarian Field Club by the Rev. Leonard Jenyns, M.A., President. The address remarks that in national museums, we expect and ought to find everything known to exist in the several classes of the animal, vegetable, and mineral kingdoms, so far as they can be acquired. But local establishments will have limited space and funds, and must, therefore, make a judicious selection. In the first formation of a museum it is not necessary to be over-particular, as objects which arouse the curiosity of the uneducated may excite a taste for the works of Nature or Art. But beyond this there must be method and principle. The provincial museum should, in the first instance, collect the productions of its own neighbourhood, for the sake not only of local students, but of visitors from other districts. The next suitable object, if there be sufficient means, may be the collection of the productions of Great Britain, and next, of other parts of the world; but in either case the collection should be purely typical—excluding closely-allied species, varieties, &c. Another recommendation is the representation by specimens of the whole life of an organism, its habits, uses, allies, and enemies: for instance, cases of insects injurious to corn or timber, showing every part of their history, with examples of others appointed to keep them in check; gall-making insects; nest-building insects, &c. It is well observed that very much of the usefulness of a museum depends on the proper labelling of the specimens, which should not be a mere series of names, but should include a short account of affinities, structure, or uses; a system exemplified at the Kew Museum of economic botany.

On this head we may refer to the excellent arrangement of the Mollusca adopted at the Liverpool Free Museum, under the superintendence of the Rev. H. H. Higgins. The visitor has before him a short account of the group he is examining, typical British specimens, typical Foreign specimens, fossil representatives, and illustrations of uses. In the accompanying cabinets, for the use of students, are collections of allied species; where necessary, there are also well-drawn illustrative diagrams.

On the same subject is a paper, read before the Dudley and Midland Field Club by Mr. John Jones, the Secretary, and headed, "Organization in Field-Club Work." The author makes an earnest appeal to his fellow-members to work out the science of the district, instancing as desirable objects the formation of a "Midland Flora;" the history of the names of Midland families and places; the study of the Coal Measure fossils, particularly with reference to the various beds; the examination of the "Permian breccia;" and other similar topics. He recommends for imitation (and we cordially agree with his recommendation) the example of the members of the Malvern Club, who are collecting materials for a Scientific Guide Book to their district. He is also anxious that the Society should take up the discussion of questions of practical mining, obtaining the co-operation of those engaged in the pursuit. It will be seen that this suggestion has already been acted upon.

The Dudley and Midland Geological and Scientific Society and Field Club.—This Society appears to be in a very flourishing condition, its 'Transactions' giving evidence of a considerable amount of work done, and of results obtained. There are two or three special features worthy of notice. Its object, according to the revised list of rules, is "to amass and diffuse practical and theoretical information respecting Geology and other sciences by the reading of papers and discussions thereon; the delivery of lectures; the formation of a library and museum; the collection of plans and general statistics relating to Mining; the publication of the Society's proceedings; by holding field-meetings; arranging scientific exhibitions in various towns in the district; and by such further means as the Committee may see fit to adopt from time to time." We find that a conversazione and exhibition of fossils, botanical specimens, diagrams, and philosophical apparatus was organized by the Society, and held at Wolverhampton in January, 1864. During the evening, papers were read "On the Working of Mines in South Staffordshire;" "On Roman Mosaics found in Britain;" "On Palæozoic Genera still existing;" and "On the Literature of Geology." In the following April, a Fine Arts, Industrial, and Scientific Exhibition was held at Dudley, which appears to have been very attractive and successful, except perhaps pecuniarily. A balance on the debtor side, however, must be considered not as so much lost, but as expenditure resulting in the accession of new members and the spread of scientific or artistic tastes. At an evening meeting held during the exhibition, Lord Lyttelton presiding, a paper was read by the Rev. W. Symonds, F.G.S., Rector of Pendock, and President of the Malvern Field Club, "On the Progress of Geological Science during the previous year." The author gave a masterly sketch of the geological discoveries of the year, including a summary of Sir Charles Lyell's conclusions on the antiquity of man. In conclusion, he remarks, "Taking the whole testimony, there can be little doubt that man, the pre-eminent creature on this planet of his Creator, has been subjected physically, morally, and intellectually to the same great law of progress that we trace throughout the system of creation from the Pre-Cambrian epoch to the present time; while if we argue from analogy we must believe in a future history of advancement and of progress." The following evening a conference of colliery proprietors, mine agents, and members of the Society was held, under the presidency of Mr. W. Matthews, and was numerously attended. Papers were read "On the Working of the Ten-yard Coal;" and "On the Discovery of Cannel Coal in North Wales." We shall refer to these papers presently. It was considered desirable to have a series of elementary lectures on Geology as part of the proceedings at the ordinary monthly meetings; and at the request of the Committee, Mr. H. Beckett, F.G.S., Vice-president, undertook to deliver a course. The first two lectures appear in the 'Transactions;' one, "On the General Principles of Geology;" and the other, "On the Coal Formation." They appear to have been well adapted to their intended object, but we must take exception to Mr. Beckett's chemical geology, especially with regard to his views on the nature, source, and distribution of alumina. Lastly, we notice that five field meetings are announced for the present year, in addition to three others to which dates are not assigned. We may now refer to three of the papers which appear in the 'Transactions.'

The Ten-yard Coal.—As before mentioned, at a conference of mine owners, &c., a paper was read by Mr. Rupert Kettle, Vice-president, "On the Yield of the Ten-yard Coal and the Best Mode of increasing it, having regard to the Safety and Economy of the Working." The method of working this magnificent seam is almost universally that known as "square work," or working by "ribs and pillars." According to Mr. Kettle's calculations, each acre contains 48,400 tons of coal as it lies untouched, whilst the average yield by "square work" may be taken at not more than 24,500 tons, leaving a deficiency of 23,900 tons. To do away with so much of this enormous waste, left partly in pillars and partly as slack, Mr. Kettle strongly urges the adoption of the "long wall" method of working. Here the seam is worked at two different periods, the upper half being first extracted, and after an interval, the lower half. No pillars are left, and the yield is increased according to various estimates from 6,000 to 15,000 tons per acre. In addition to this, it was maintained that the safety to the men in long-wall working is very much greater than by the ordinary method, whilst the ventilation is far more easily rendered efficient.

The Recent Discovery of Cannel Coal in North Wales.—This paper, by Mr. H. Beckett, F.G.S., may be considered as supplementary to the information respecting the Flintshire and Denbighshire coal-field, given by Mr. Hull, in his 'Coal Fields of Great Britain.' That geologist states that "the strata of the Flintshire coal-field rarely attain a great depth, and that the greater portion of the coal, being placed so near the surface, has already been exhausted." When these statements were made, however, and until within a late period, the main coal was the lowest seam generally wrought in Flintshire. At Mr. Beckett's recommendation, Messrs. Jones sank below this seam at Leeswood Green. Here the main coal was 154 ft. from the surface; below it several workable seams of coal were passed through; and at about 93 yards below the main coal, a bed of cannel was reached. This seam, known as the Leeswood Cannel, was four feet thick. The general direction of the dip of the beds is east, or north-east; but a few hundred yards west of the first shaft a fault of 90 yards occurs, bringing the cannel to within about 35 yards from the surface, and at the same time reversing the dip. The seams of coal between the main coal and the cannel are seven or eight in number, giving a thickness of 16 feet to 24 feet of coal. There are also additional seams below the cannel, and some valuable iron ores. The quality of the cannel is extremely variable. At Leeswood, the roof is a rich "oleaginous" shale. Next below comes the "smooth cannel," which passes down into "curly cannel," so called from its peculiar fracture. According to a report by Dr. Andrew Fyfe, of Aberdeen, the Leeswood Green coals are of excellent quality as gas-producing coals, especially the curly cannel, which may be considered as nearly of the same value as Torbane Hill coals; whilst for coke-producing, it far surpasses the latter. Some of the shales associated with the cannel yield a fair percentage of paraffin. In some places, the cannel is entirely of the "smooth" variety, or is replaced by ordinary bituminous coal. Mr. Beckett considers the Leeswood cannel of Flintshire to correspond with the lower yard coal of Ruabon, in the Denbighshire coal-field, which indeed has recently been met with south of Ruabon as a true cannel, nearly four feet thick. Complete sections of the strata in Flintshire and near Ruabon are appended to the paper.

The Distribution of Organic Remains in the North Staffordshire Coal-field.—This paper, by Mr. John Ward, is highly important. It has been often remarked that whilst we are well acquainted with the fauna and flora of the coal formation as a whole, scarcely anything has been done towards an examination of its constituent beds in any given locality, with the view of ascertaining what species or genera are specially characteristic of its several subdivisions. In the present paper, this object is attempted for the coal-field of North Staffordshire; and more especially that part of it called the Potteries coal-field. The coal measures have been divided by Mr. Smyth into four parts:—1st. The upper measures, consisting of marls and clays down to the top of the Red Mine, 1,000 feet. 2nd. The Pottery coal and ironstone measures, down to the Ash or Rowhurst coal, 1,000 to 1,420 feet. 3rd. Lower thick measures, including the Winpenny and 17 or 18 seams of coal above two feet thick, 1,400 to 2,400 feet. 4th. Lowest measures, including the Wetley and Shafferlong coals, about 800 feet. The upper or 1st division is not rich in fossils, but Anthracomya Phillipsii is abundant. The 2nd or Pottery measures have an extraordinary series of organic remains. About twelve yards above the Bassey mine ironstone is a bed of freshwater limestone, with Spirorbis carbonarius and scales of fish; this seems to correspond with the Ardwick limestone of the Manchester coal-field. The Bassey mine ironstone (Red mine) has an immense number of Anthracomya Phillipsii, with large specimens of Stigmaria. The Gubbin ironstone has Megalichthys Hibberti, Diplodus gibbosus, and spines of Rhizodus Hibberti. Palæoniscus, which is common in other beds, is here rare or absent. The deep mine ironstone is full of beautiful and complete fish, including several species of Palæoniscus, also Cycloptychius carbonarius, (Hux.), Cælacanthus, Diplodus, Megalichthys, and Ctenoptychius. In the shale of the Bay coal, there are marine fossils, which is remarkable, the seam being in the upper measures. In the lower thick measures, we find that the Ash coal bass contains several species of Palæoniscus, one having characteristic granulated scales; also Rhizodus, Helodus, Clododus, and other fish. The Burnwood ironstone has fine specimens of Anthracomya Adamsii. The ten-foot coal measures have a "mussel bed" formed of the compressed shells of Anthracosia and Anthracoptera. The 4th division, or lowest measures, contain a valuable bed of earthy hæmatite. In many of the shales of this division, there are multitudes of Aviculopecten papyraceus, together with Posidonia, Goniatites, Lingula, and Orthoceras. It appears that amongst the fish, the genera Megalichthys, Palæoniscus, Cœlacanthus, and Platysomus range throughout the whole series forming the coal measures. The paper is followed by detailed descriptions of the principal genera of fish found fossil in the coal-field, and by a carefully drawn-up table of the organic remains of the same series of rocks, both of plants and animals, the species peculiar to each bed being indicated. Very great advantage would result if each of our coal-fields were examined as closely and described as minutely as that of North Staffordshire is in this paper.

The denudation of Rocks in Devonshire.—We have before us two papers by Mr. W. Pengelly, F.R.S., reprinted from the 'Transactions of the Devonshire Association for the Advancement of Science, Literature, and Art.' In the first the author brings under notice the principal proofs of denudation evidenced by the present condition of the rocks of Devonshire. Commencing with the axiom that "all strata are immediately or mediately the offspring of unstratified rocks," he proceeds to show that rocks of organic origin are equally derivative. The limestones and chalk of Devon are due to animal agency; but the carbonate of lime, of which they consist, was extracted from the sea-water, which in turn derived it from the solution, through the agency of thermal and acidulated waters, of rocks or rock detritus which contained it; in other words, by the destruction of earlier rocks. The operation of building up the limestones by the growth of crinoids, shells, and coral reefs, must have required an inconceivable space of time, if the Devonian sea, like the present, contained no more than 3 parts in 100,000 of carbonate of lime. With regard to the original source of lime, it is remarked that the granitic class of rocks is poor in calcareous matter, but those of the augitic or hornblendic group, including Basalt, Dolerite, and Diallage rock, often contain 10 per cent. of lime; it is not improbable, therefore, that there was an early and large destruction of unstratified augitic rocks. The Bovey Tracey lignite is of vegetable origin, but with it are interstratified sands and clays derived from the Dartmoor granite. The whole formation is at least 300 feet in thickness, of which the vegetable matter barely constitutes 45 feet. The crystalline schists of the Start and Bolt, at the southern angle of Devonshire, are metamorphic; the change they have undergone implies the former existence of overlying beds of great thickness, which subsequently to the change must have been swept away. There was again a further destruction, for the Bigbury Bay outlier of Triassic conglomerate is mainly composed of fragments of the schists. The Dartmoor granites have a similar history. They have been formed under the pressure of overlying masses, and according to some modern views they were formerly in the state of beds, which have therefore been destratified; in this case they must have been derived from previously existing rocks. Denudation also took place during pauses in the process of sedimentation. This is seen not only in the Triassic series, but also in the Devonian limestone near Hope's Nose, Torbay. The limestone is there seen to be composed of two unconformable series: the lower, which includes several interstratified beds of volcanic ash, having been violently contorted and denuded before the deposition of the upper undisturbed beds. The Torbay limestones, however, represent but a small fraction of the Devonian era. The outliers which are found scattered over the county indicate the former extension over a great part of it of the Trias, greensand, and chalk, which have since been almost entirely removed. Thus there are outliers of Trias on the shores of Bideford and Bigbury Bays, and one of greensand near Bideford, forty-three miles from the principal mass of the formation at Blackdown. On some of the greensand hills there are thick accumulations of chalk flints unrounded and untravelled. The chalk which formerly contained them, and which must have been of great thickness, has been quietly removed by the dissolving power of rainwater containing carbonic acid.

The islets fringing the Devonshire coasts are outlying relics of an ancient coast-line. Other proofs of destructive agency are afforded by "terraces of denudation," where the retreating tide leaves a rocky platform instead of a sand or shingle beach; the water having reduced to a plane surface the outcrop of highly-inclined strata. Similar terraces are seen on the summits of limestone hills now inland. Raised beaches occur round the coasts about 30 feet above the sea, usually occupying platforms or terraces in hard rocks. Occasionally slabs of rock are seen to be cemented to the faces of limestone cliffs. These have formerly fallen into fissures, and been there cemented by water containing carbonate of lime. Subsequently the mass of rock lying between the fissure and the sea has been removed by the waves, leaving the blocks in their present position. The Budleigh Salterton beach pebbles offer striking proofs of repeated denudation. The beach extending from Sidmouth to the eastward extremity of the county is almost entirely composed of quartz pebbles derived from a pebble bed near Budleigh Salterton. The pebbles have been recently shown to contain Lower Silurian fossils similar to those occurring in the quartzite beds of Normandy (*see* 'Quart. Jour. Geol. Soc.,' vol. xx. p. 283; Aug. 1864). Mr. Pengelly hence deduces the following series of changes:—1st. The denudation during the Lower Silurian era of pre-Silurian rocks containing quartz, and the deposition of the triturated material. 2nd. The production, by denudation, of a large amount of débris, which was deposited on the arenaceous beds. 3rd. The metamorphism of the latter into quartzite. 4th. The denudation of the overlying strata. 5th. The denudation of the quartzites during the Triassic period, and the formation of the pebble-bed. 6th. The denudation of the pebble bed during supracretaceous periods, by which much of the ancient gravel of south-eastern Devonshire was produced. 7th. The continued denudation of the pebble-bed to form the modern beach of Budleigh Salterton. The author thinks that the crystalline rocks of the south of Devon and Cornwall, including those of the Bolt and Start, the Dodman district, and Eddystone, may be parts of one great system, from which the Budleigh Salterton pebbles may have been derived.

The Introduction of Cavern Accumulations.—In this paper Mr. Pengelly shows that the caverns of Devonshire may be divided into four classes, respecting the modes in which their contents were introduced. In some instances, at least, the existing contents of caverns were carried in long after the excavation had been completed. The famous Windmill Hill Cavern at Brixham had certainly been twice filled and emptied before the introduction of the mass of materials which was found in it and excavated in 1858. This is proved by the remains of two former stalagmitic floors, one of which formed a kind of ceiling to a cavity which existed when the cavern was examined, and below which was the most recent accumulation of materials.

The first mode in which accumulations are shown to be introduced into caverns is that through vertical openings communicating with the surface. Several caves occurring in the limestone of Oreston were met with from 1816 to 1822, and described by Mr. Whidbey, who failed to detect any such opening. But in 1858, Mr. Pengelly had an opportunity of examining one of the same series, situated, as he believed, along the same original line of fracture. The roof was eight feet thick, and consisted of large angular masses of limestone cemented with carbonate of lime. This was evidently the position of the original fissure, through which the materials of the bone bed had been slowly and gradually introduced. There had been pauses in the operation, as shown by the frequent occurrence of pure white stalagmite separating masses of breccia. The breccia forming the roof might easily be mistaken for ordinary limestone traversed by numerous irregular and coarse veins. Other examples are mentioned of fissures filled from above, and destitute of roof, though containing bones of the ordinary cave animals well preserved. In some instances, as at Daddy's Hole, Torquay, the fissure has been only in part filled up.

Another mode of introduction is by engulphed streams. The Brixham Cavern consists of a series of galleries having the direction of the two systems of joints which pervade the Devonian rocks of the district, but their roof-joints are too close-fitting to allow anything more than water to penetrate. In this case, however, the cavern has four external horizontal entrances, and the mode of introduction is strikingly shown by the fact that every bone and stone lay with its longest axis in the plane of the deposit, or in the precise position which would have been given to it by a running stream, and not by the sea. It would appear that the water entered through each of the four external openings, and after flowing almost horizontally, was discharged through a highly-inclined shaft within the cavern, the walls of which shaft are polished and scratched as if by the long-continued action of running water charged with detritus. It was also evident that the introduction of material was intermittent, the volume of the stream having been at times so small as to leave parts of the galleries comparatively dry, and so allowing the formation of a cake of stalagmite. Such engulphed streams exist in some caverns at the present day.

The two remaining methods of introduction which are mentioned by the author as probable, are the introduction of accumulations by the sea, and that by occasional land floods; but the instances which seem to support these latter hypotheses are as yet somewhat isolated.

REVIEWS.

KÖLLIKER'S OUTLINES OF THE LOWEST FORMS OF LIFE.*

About 25 years ago Professor C. G. Ehrenberg, of Berlin, discovered and described a new group of living forms of animal and plant life, all of microscopical dimensions, which he called the Infusoria. Their external appearance was delineated with tolerable accuracy in a work published by the discoverer in Berlin, and translated into English by Pritchard, and thus the new types were made known to the scientific world, and became the objects of close investigation amongst Continental observers. This was in reality the foundation stone of micro-zoology and micro-phytology, and as the father and pioneer of microscopical science, the fame of Ehrenberg will abide for ever.

But although the great Prussian naturalist was an indefatigable collector, and delineator of outward forms, he unfortunately possessed but limited anatomical knowledge. The same spirit that induced him to persevere in adding fresh treasures to our microscopical collections was not carried into his investigations of their anatomical and biological characters, but that spirit is, in a perverted shape, manifested in a dogged adherence to his primitive views. Ehrenberg built up a hasty and superficial system of classification, based on features to a great extent imaginary in his microscopical favourites, which has not borne the test of time, and although it has not interfered with his great fame as a pioneer, has yet detracted somewhat from the value of his discoveries.

It has been left, then, to others not so able, perhaps, but certainly less prejudiced, to correct Ehrenberg's errors and develop the science of which, as we have said, he was the founder; and although well known to the students of this branch of science, the names of these observers have not been brought prominently before the reading public. They are Dujardin, Cohn, Stein, Jules Haime,† Gegenbauer, Claparède, Lachmann, Lieberkühn, Engelmann, and in quite recent times, Balbiani, of Paris, along with a few more, chiefly Continental observers. By these gentlemen, the true nature of the "Infusoria" has been to a great extent defined, and systematic zoologists have been able, in some degree, to arrange and classify them in the various groups to which they belong. As to the phases through which the history of the true Infusoria has passed, these are easily summed up. Ehrenberg considered (and we believe still considers) them to be microscopical animalculæ of comparatively high organization; and the error he committed was to seek and imagine that he had found in them a structure identical with that of the higher animals. That they *are* to a certain extent so endowed is quite true, but whilst he overlooked or failed to trace the homologous features which actually exist, he invested them with others which they do not possess, and wherein they are in reality rather allied to plants than to animals. Thus he ascribed to them a mouth, throat, numerous true stomachs in which he and his disciple Pouchet professed to see distinct membranes (hence Ehrenberg's term Polygastrica), and a connecting intestinal canal; also a heart, true circulation, and a "nucleus" or germ, with a "nucleolus" or germinal vesicle. Their method of reproduction he believed to be similar to that of plants, by subdivision, and gemmæ or buds. It may be briefly stated that although he was to a certain extent correct in his observations concerning the multiplication of these forms, yet, as will be shown presently, it is precisely here that they are most closely linked to the animal kingdom, whilst his imaginary stomachs ally them rather to some of the lowest forms of plant life.

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* 'Icones Histiologicae, oder Atlas der vergleichenden Gewebelehre,' herausgegeben von A. Kölliker, Professor der Anatomie in Würzburg. Erste Abtheilung. 'Der feinere Bau der Protozoen.' Mit 9 Tafeln und 15 Holzschnitten. Leipzig, Wilhelm Engelmann. ('Histological Sketches; or, an Atlas of Comparative Histology,' by A. Kölliker, Professor of Anatomy at Würzburg. Part I. 'The Minute Structure of the Protozoa,' with 9 Plates and 15 Woodcuts. 4to. Leipzig: Engelmann.)

† Whose name is unaccountably omitted by the author, although, if we recollect rightly, he was one of the first to contribute valuable knowledge on this subject, in the pages of Kölliker's own journal.

In the course of time, and after a somewhat acrimonious contest, the opponents of Ehrenberg succeeded in sweeping away his whole anatomical system, and Dujardin degraded the infusoria to the position of unicellular animalculæ, formed of a substance which he called "sarcode," almost void of organic structure, but possessing the power to ingest food through an oral aperture, that food collecting in "vacuoles," or improvised globules (the stomachs of Ehrenberg), and rotating in or with the sarcode, somewhat after the manner of the semi-gelatinous "protoplasm" in certain lowly algæ. Other observers compared the "heart" or "contractile vesicle" to the "vascular water system" of certain "vermes," and the "blood" was believed to be a liquid admitted from without, rather than a true circulating fluid, the result of digestion. Thus, if we may be permitted to indulge in a passing joke, the poor little infusoria were made to look smaller than they really are; but they were reserved for a higher destiny, chiefly in consequence of the able researches of Dr. Balbiani of Paris, to whom reference has often been made in these pages; it will be found from the work under review, although they are placed by the author below three other groups of Protozoa, that they are really possessed of a tolerably well-developed animal organization.

The "polygastric" system of Ehrenberg has, it is true, disappeared for ever, and the alimentary apparatus consists of an oral aperture or mouth, a gullet, which the author believes to be in all cases contractile, temporary digestive vesicles which rotate within the unicellular animalcule, a contractile vesicle of the nature of a heart; a circulating system of minor vesicles, an anal aperture for the discharge of exhausted alimentary substances. Of the "circulating apparatus," we may say in passing, that we believe even Professor Kölliker under-estimates the extent of its development, for from personal observation we feel satisfied that in many of the larger and more active Infusoria, it foreshadows through a recurring, if not constant, system of accessory canals, the circulating apparatus of the planarian worms and of other animals ranking higher in the scale. The feature, however, in the Infusoria which has wrought the most important change in their zoological value is the reproductive apparatus, for it is clearly shown in accordance with the researches of Dr. Balbiani that they are provided with the essential elements which distinguish the sexes, and that they follow, in this respect, the great developmental law prevailing throughout the animal realm.

When it is remembered that the forms here treated of vary from $\frac{1}{500}$th down to $\frac{1}{1000}$th of an inch in length, it must be conceded that they are highly organized, and it may be added also that they possess active locomotive powers, and that although no trace of a nervous system has yet been discovered, it is highly probable that they have the capacity of selecting food, and (according to many observers, including the author) are endowed with a will, however limited in this instance may be the acceptation of the term.

Below the Infusoria Professor Kölliker places one other group of animalculæ, namely, the *Gregarinidæ*, microscopical parasites often found in the lower types of aquatic worms, and *Entomostraca*, which are still more obscure in their structure and development than the Infusoria; and next in order above the last named are what he terms the *Rhizopoda* proper, including the well-known *Actinophrys sol*, the *Globigerinæ*, and *Foraminifera.* The last two are the best known of the Protozoa in England, for they have been made the subjects of special study by our English microscopists, and the chief authorities are Dr. Carpenter, Professor Williamson, G. C. Wallich,* H. J. Carter, and Dr. Strethill Wright.

Little is, however, known of the physiological nature of this group, their beautiful many-chambered shells being their chief attraction, and we are induced to pass them by for the purpose of introducing our readers to the one placed next above them by the author, namely, the *Radiolariæ*, which have not yet, as far as we know, been systematically described in the English language, and are but little known even to the initiated in Microscopical Science. Indeed, it is only necessary to state that although the author of the work before us describes with great minuteness thirteen distinct genera and several species, there is no mention of any one of them, nor of the group itself, in the second edition of the 'Micrographic Dictionary,' in order to show that they are all recently discovered types.

And what exquisite forms do these Radiolariæ exhibit! We feel sure that their beautiful shapes have only to be seen by our microscopists, to make them forget Diatoms and Desmidiæ in their anxiety to possess them; for, along with the beautiful cases of these they combine all the attractions of living and moving beings, and their interest is by no means confined to their external coverings. Some of them resemble globular groups of pearls, with a brilliant central gem of more solid consistency, the whole emitting bright rays (*pseudopodia*) in every direction; and on examining the constituent globules, each one is found to be more or less highly organized. Others are still more beautiful and interesting; one, for example, resembles a conical Japanese hat of honeycombed silex, bristling all round the rim and on the apex with spikes, and harbouring in the crown of the silicious fabric the multicellular animalcule, from which innumerable rays are projected. Another is a perfect hollow silicious sphere of filagree, also honeycombed, and in the centre floats a beautiful sun, whose rays penetrate the open framework of the globular case; and a fourth, more exquisite perhaps than any of the preceding, might serve as one of the insignia of some noble order, for it presents the appearance of a jewelled star. The central portion is the hyaline animalcule resembling a globular pearl in appearance, from which project silicious rays, some lance-shaped, others straight, and all meeting within the central globe. There are many more such forms, varying in the shape of the central soft portions, or in that of the radiating silicious skeleton, or of the surrounding casework, but all are more or less graceful and elegant, and the delineations of them in the present work have only to be seen to render them eager objects of search and favourite subjects for investigation.

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* See his paper No. I. 'Quarterly Journal of Science,' and Figs. 1–6 in the Plate appended to the paper.

Little seems yet to be known of the physiological attributes of the Radiolariæ, and for what has been revealed in this respect, the student will find himself indebted to Ehrenberg, T. H. Huxley, J. Müller, Claparède and Lachmann, A. Schneider and E. Häckel. An account of the minute anatomy of the sponges concludes this work on the Protozoa; and these are described with great clearness, justice being rendered to all observers who have contributed to our knowledge of their Natural History.

The opinions of Professor Kölliker on all matters connected with microscopic anatomy and micro-zoology, are entitled to great consideration, and it will be interesting to some of our readers to hear his opinions on two or three debated topics. After carefully reviewing the question of the distinctive characters of the lowest plants and animals, he comes to the conclusion that there is no well-defined distinction between them. Again, both as bearing upon this question, and as a matter of interest to psychologists, it may be mentioned that he believes the Infusoria to possess a will, for in describing how the cilia of *Paramecium bursaria* may be excited to movement by the action of acetic acid after they are separated from the body, he says, this shows that although these organs are generally under the controul of the animal's will, they are not *necessarily* so ("was zugleich zeigt dass diese Organe wenn auch gewöhnlich, doch nicht nothwendig unter dem Willeneinflusse des ganzen Organismus stehen."—p. 10).

As the author cites the presence of Cilia in the lowest plants, as well as the lowest animals, as part of the evidence to prove that it is impossible to distinguish one from the other, we have the choice between believing that the motile ciliated unicellular plants are endowed with a will; or that a will is one of the characteristic attributes of animals only, from the highest to the lowest. It is not our intention further to discuss the subject here, it only shows how interesting is the study of these lowly forms of life. The author believes that the Infusoria are provided with urticating organs somewhat similar to those of the Hydro-Medusæ, and he describes them with great minuteness. The sponges, he considers, possess the first approach to muscular fibre, and for this reason, amongst others, he places them at the head of the class Protozoa. His observations lead him to believe that he has found Spermatozoa in sponges; the reader will, however, be disposed to agree with him that further investigations are needed to confirm the fact. Finally, he explains the method in which he believes the beautiful sponge spicules to be produced; having discovered in many of them a central core, which he says he has seen protruding beyond the barrel of the spicule, and which, he thinks, forms the nucleus that serves as the basis of its development.

In directing the notice of our English microscopists to this beautiful work of Professor Kölliker, by far the best handbook of the Protozoa extant (if its shape will admit of its being called a handbook), we cannot help regretting that more attention has not been paid in England to the forms of which it treats. It is true that the history of the Foraminifera, and to some extent that of the sponges, are the fruits of British intellect, but the commonest types of Protozoa, and those most easily accessible, have been sadly neglected by our biologists, whom we should be glad to see rank side by side with Continental observers in this branch of Zoological science. The investigation of these forms will throw fresh light upon the whole question of species. Do any of our investigators fear to approach the subject, lest the results should "unsettle" their minds? If so, it will always be left to foreign microscopists, who are less impressible in that respect.

The present work, which presents, as we have already said, by far the most complete epitome of the anatomy and physiology of the Protozoa, forms the first of a series, which is to embrace the whole animal kingdom, and the well-known labours of the author leave little doubt that the remaining portions of his task will be executed with equal ability. We presume that arrangements will be made to translate each section of the publication as it appears; meanwhile such of our readers as are able to study it in the original tongue will do well to possess themselves of what promises to be an invaluable series of "Histological Sketches."

THE LIFE OF THE SECOND MARQUIS OF WORCESTER.*

THE work before us is of a twofold character; it possesses interest both for the historian and for the man of science, and it is difficult to decide in which direction the preponderance of interest lies. In the first half of the work the author has given a history of the life and times of the second Marquis of Worcester, illustrated by a number of private letters (now printed for the first time), which throw much light on the political history of England, during the civil wars of the time of Charles I., and further gives us some insight into the manners, customs, and the tone of thought which prevailed at this period. Next follows a reprint of the celebrated 'Century of Inventions,' upon which the scientific fame of the Marquis is entirely founded; this is annotated with great care by the author, and is of special interest to those who study the history of science.

The period comprised within the life of the Marquis was one of the most eventful in the annals of England. The accession of the House of Stuart in the person of a king of weak and vacillating character, possessing most extravagant notions of his own prerogative, delighting in flattery, easily swayed by favourites, pedantic, most vain of his learning; in every way unsuited for exercising the powers of a king: the succession of his son, who possessed many of his own traits of character, was more vacillating perhaps, undoubtedly less sincere, and more determined to uphold the divine right of kings; the gradually increasing power of the Commons; the rupture between the King and the Parliament; the civil wars; the final dominance of the democracy, and the violation of all kingly rights; the temporary subversion of the monarchical government; the Restoration—all this occurred during the lifetime of the Marquis. Let us turn to revolutions of another kind. The mode of scientific thought, the manner of interrogating nature, was changed during this same period: the physical philosophy of Aristotle, which had obtained for 2,000 years, was supplanted by that of Francis Bacon; but no rights were violated here, the old philosophic dynasty had long been falling into disrepute, and latterly had retained its sway by force alone; its downfall was hailed with joy; the new dynasty was welcomed by all, and recommended itself to all; it came quietly and peaceably, for its founder had forbidden that force should be resorted to for its establishment.† A new light had dawned on the human intellect, a fresh impulse had been given to it, and hereafter it was to flow in hitherto unknown channels. The change was going on before the eyes of the Marquis, he saw the last impotent efforts of his Church to curb the free workings of the human mind; he witnessed the birth of the new philosophy, the publication of the 'De Augmentis,' and later, that of the work which in all after ages was to direct the philosophic mind,—the 'Novum Organum.' But we question if he ever read this latter work: he certainly did not act up to its precepts; the 'Century' is not the work of a Baconian philosopher. We regret, moreover, that Bacon is scarcely mentioned in the book before us, for we conceive that no work which treats of the science of the first half of the 17th century can be at all complete without much mention of him; but we do not think that Mr. Dircks is imbued with the spirit of the Baconian method:—"All invention," he writes, "is progressive—first, laws of Nature are discovered; then, applications are invented; and last, follow divisions, and subdivisions of endless great, small, and minute improvements." We submit that the views inculcated in this sentence, are entirely opposed to the true spirit of inductive philosophy, as well as to the experience gained from past ages; throughout the history of science we find that laws of nature have been deduced from applications of them, not the reverse. The pump was invented ages before anything was known of the pressure of the air; the steam-engine long before the properties of condensable vapours had been studied.

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* 'The Life, Times, and Scientific Labours of the Second Marquis of Worcester; to which is added a reprint of his "Century of Inventions."' By Henry Dircks, C.E. London: Bernard Quaritch. 1865.

† "Dixit Borgia de Expeditione Gallorum in Italiam, eos venisse cum cretâ in manibus ut diversoria notarent, non cum armis ut perrumperent; itidem et nostra ratio est, ut doctrina nostra animos idoneos et capaces subintret; confutationem enim nullus est usus, ubi de principiis ut ipsis notionibus, atque etiam de formis demonstrationem dissentimus."—*Novum Organum*, lib. i., aph. 35.

Edward, second Marquis of Worcester, was born in 1601; he was the son of Henry Somerset, Lord Herbert, who was created Marquis of Worcester by Charles I., in 1642. We hear but little of the second Marquis till the breaking out of the civil war in 1640. As a young man he had a taste for mathematical and mechanical studies, and undoubtedly spent much time in putting in practice various schemes, and in making models of different mechanical devices. Shortly after his marriage in 1628, he engaged the services of a foreign engineer, named Caspar Kaltoff, whom he appears to have retained permanently in his employ; in the dedication to the 'Century' (published in 1663) he speaks of him as having "been these five-and-thirty years, as in a school under me employed." The Marquis and his father were most devoted to Charles I., and on the commencement of the civil war they warmly joined his cause. In 1640 a commission was granted to the Marquis empowering him to levy forces in several counties in England and Wales, and in 1642 he was appointed general of South Wales, a number of troops raised by his father being placed under his command. Nor did the Marquis assist the cause of the King by services alone, he advanced large sums of money, and repeatedly levied forces at his own expense. At a later date, in a petition presented to Charles II., he estimates the money "that I have spent, lent (and lost?) for my King and country," at 918,000*l*. In 1645 he was sent to Ireland by Charles I., with orders to conclude a peace with the disaffected party by granting some important concessions to the Roman Catholics, on the condition that they should send 10,000 troops to England for the King's service; but the object of his visit was discovered, and in 1646 he underwent an examination before the Lord Lieutenant and the Council of Ireland, which led to his imprisonment in Dublin Castle; he was shortly afterwards released on bail. Charles denied all cognizance of the matter of the treaty, and some have affirmed that the Marquis was guilty of forgery; it has been satisfactorily proved, however, that he was commissioned by the King to treat with the Catholics; at the same time, while we think that Charles is to be chiefly blamed, we cannot entirely exonerate the Marquis. In 1648 he quitted Ireland, and passed over to France, where he remained in exile till 1651, when he returned to England to privately ascertain the feeling which prevailed relative to the return of Charles II.; he was discovered, however, and imprisoned in the Tower in 1652, but was released on bail in 1654. In the following year the Marquis wrote his 'Century of Inventions.' At this time he was in great pecuniary distress, his castle in Monmouthshire had been destroyed by the Parliamentarians, his estates had been confiscated, and his money had been devoted to the late King's service; in 1655 Cromwell allowed him three pounds a week for his better maintenance. At the Restoration he might with justice have hoped for a return of at least a part of his loan to the late King, but it was otherwise, for although he constantly petitioned both the King and the Parliament, little notice appears to have been taken of his requests, except to return him his heavily encumbered estates, and to grant him a monopoly of an engine for raising water by steam which he had recently invented. It must be allowed that Charles ill-rewarded one of the most loyal of his father's subjects, one who had sacrificed all for his King. The Marquis died in London, and was buried at Raglan, in Monmouthshire, on April 17, 1667.

The 'Century of Inventions' was written in 1655, and was first printed in 1663; a MS. copy (not the original, which does not exist) is preserved in the Harleian Collection. The 'Century' gives the titles alone of a number of inventions, or rather improvements on former inventions; at its conclusion the Marquis promises "to leave to posterity a Booke wherein under each of these heads, the meanes to putt in execution, and visible tryall, all and every of these Inventions, with ye shape and forme of all things belonging to them, shall be printed by brasse plates;" it is much to be regretted that this was never done, for from the obscurity of the language employed in the 'Century,' it is impossible to surmise the exact nature of any one of the inventions mentioned therein. This work has been reprinted no less than twenty-three times; for the completeness and extent of its annotations we believe this to be the most valuable reprint which has appeared; Mr. Dircks has carefully traced the early history of most of the inventions alluded to, and for this he is entitled to the thanks of scientific men:—we consider that these annotations constitute some of the most valuable parts of the work.

We will very briefly consider the nature of the various inventions, the titles of which are given in the 'Century.'

The first and second inventions relate to seals of different kinds, capable of showing the day of the week, the date in full, the names of witnesses, the name of any one of ten thousand places at which a document may be sealed, the number of lines contained in a document, and other matters of importance in connection with the signing and sealing of contracts.

Inventions 3 to 5, 33 to 43, 51, and 75 relate to secret correspondence. Writing in cipher was much practised during the sixteenth and seventeenth centuries, and we can understand why this was the case when we remember the instability of the times, the absence of all postal regulations, and the consequent necessity of sending letters by messengers, who were constantly exposed to the attacks of highwaymen. Several works relating to different modes of secret correspondence were printed during the 16th century; Francis Bacon ('De Augmentis,' lib. vi. cap. 1) describes at length a cipher which he invented when a young man. Many of the letters of Charles I., written during the period of the civil war, are in cipher, as also are some of the letters of the Marquis to the King.

Inventions 81 and 82 relate to the conveyance of letters secretly by concealment in a comb, and in the handle of a knife, fork, or spoon.

Invention 32 treats of a universal character intelligible in any language.

Invention 76 is entitled, "How to write in the dark as straight as by day, or candle light." Mr. Dircks suggests that this might be effected by writing on a ground-glass box lid illuminated from beneath.

Inventions 6, 7, and 52, refer to telegraphy. The first telegraph was invented by Æneas Tacticus, and was for the purpose of enabling two armies acting in concert to communicate with each other at a distance: one or two other forms were invented in the age immediately preceding that of the Marquis, but we have no record of how they were worked. The 52nd invention ("How to signify words and a perfect discourse by jangling of bells of any parish church") brings to our mind Sir Charles Bright's recently-invented bell-telegraph, an instrument of such efficacy that forty words may be transmitted in a minute: the bells are struck by weighted magnetic needles.

Inventions 9 to 15, 65, 93, and 96 relate to naval affairs, chiefly in connection with naval warfare. In the annotations to the 15th invention ("A way how to make a boat work itself against wind and tide"), Mr. Dircks has given an interesting historical account of the introduction of paddle-wheels, from which we learn that in an Italian MS., attributed to the fifteenth century, a sketch is given of a boat furnished with two paddle-wheels, fixed on a large vertical wheel, turned by the hand. Further, in 1521, an engraving was published of a vessel provided with paddles, worked by animal power; and again, in 1574, 1578, and 1651 we have notice of similar schemes, so that the Marquis had abundance of previous matter to help him.

Inventions 8, 24, 28 to 31, 44, 49, 50, 58 to 64, 66 to 68, 73, 80, 94, and 95 refer to gunnery, the construction of fortifications, and other matters relative to military affairs. As prominent among these we may mention a "key pistol," which may be used either for unlocking a door, or for piercing a breastplate, as occasion may require; a method of causing a pistol to discharge a dozen times with one loading; a ready way of loading musketoons on horseback; and a method of rapidly constructing a cannon-proof fortification.

Inventions 20 to 22, 53 to 55, and 57 relate to hydraulics.

Inventions 23, 47, and 78 relate to horology. In 23 a water-clock is mentioned, which shows hours, minutes, and seconds; also the motions of the heavenly bodies, and of the earth, according to the Copernican system; not many years before Galileo had been imprisoned by the Inquisition for daring to promulgate the Copernican theory, it is therefore with pleasure that we find the Marquis (a Catholic) embracing a theory the propagation of which his Church had endeavoured to suppress; it is a sign of the rapidly decreasing power of the hierarchy which had so long ruled supreme. In 47, we have the description of a metal ball, which, when thrown into water, floats in such a manner as to indicate the exact minute of time. The 78th invention treats of a watch which does not require winding, but must be consulted occasionally. The commentator suggests that it was probably so contrived that by opening its case to see the time, it was wound up. The clocks of this period were very inaccurate; a few years after the publication of the 'Century,' Robert Hooke introduced the circular pendulum and other improvements, which greatly increased the accuracy of horological instruments; Huyghens also contributed much in this direction.

We may mention together the following miscellaneous inventions, which cannot be classed under any special head:—(56) a contrivance for producing perpetual motion; (84) a machine, by means of which persons ignorant of arithmetic may effect numerical calculations; (97) an instrument, by which an unskilful person may take the perspective of anything; (19) a contrivance for disengaging run-away horses from a coach. This was patented by the Marquis in 1661; if we remember rightly, a patent having the same object was taken out in England about three years ago. (45) a means of lighting a candle readily at any time of the night without rising or putting one's hands out of bed. The commentator mentions that it is stated in a work published in 1661, that one Caravagio, of Sienna, constructed a clock which would awake a man at any hour he pleased, and at the same time strike a light by flint and steel. We observed the other day, in the Dublin Exhibition, a small clock of German manufacture, described as "An alarum, lighting a candle when striking." (74) a door, which by the motion of its handle may be made to open either inwards or outwards; (48) a screw-like ascent, to be substituted for stairs; (83) a mill for rasping hartshorn; (87) a mould for casting candles.

Invention 17 relates to a garden to be floated on the Thames, and to contain trees, fountains, bathing-places, banqueting houses, and mills for producing music; the commentator adds, "The whole offers one of those raree-show designs in which our great-grandfathers delighted, and the descriptions of which formed the staple of their scientific discussions in polite society." We do not agree with Mr. Dircks here, for shows of this description were more in vogue in the time of Henry VIII. and of Elizabeth than in that of Charles I., and we cannot think that *scientific* discussion was ever wasted on such subjects at any period, certainly not so late as the age of Bacon and his immediate successors.

Inventions 69 to 72 and 79 relate to locks and keys. The lock mentioned in 72 is so constructed that the way of opening it may be varied ten millions of times by the owner; moreover, if a stranger attempts to unlock it, an alarum is set going, and his hand is simultaneously caught in a trap; the lock also shows how much money has been extracted from the box to which it is affixed, and how often it has been opened since the owner last opened it: the latter part of this description unfortunately annuls the former, for it shows that the lock, in spite of all its advantages, can be opened by others than the owner.

We have next to mention various automata, which remind us greatly of some of those described by Hero, of Alexandria. First (18), we have an artificial fountain capable of producing ice, snow, thunder, and the chirping and singing of birds; next (46), comes the mention of an artificial bird which may be made to fly; 77 is entitled "How to make a man fly; which I have tried with a little boy of ten years old in a barn, from one end to the other, on a hay mow." From the time of Dædalus men have attempted to fly; not two months ago we read an account of a Frenchman who had succeeded in constructing wings which enabled him to fly a short distance; Roger Bacon believed in the possibility of flying; Hooke employed his fine mind for a length of time in endeavouring to devise modes of flying; indeed, the intellect wasted on this futile search, might, if directed into other channels, have produced gigantic results. Invention 88 relates to a brazen head, into the ear of which if a man whispers, he receives an answer from the mouth of the figure in French, Latin, Welsh, Irish, or English; this was by no means the first talking automaton—Roger Bacon, Albertus Magnus, William Bourne, and Bishop Wilkins had each constructed a similar device.

Inventions 85 and 86 relate to instruments of torture: the one, a chair which imprisons those who sit in it; the other, "A little ball made in ye shape of a plum or peare, which being dexterously conveyed or forced into a bodyes mouth shall presently shoote forth such and soe many bolts of each sydes, and both ends, as that without ye owners key can neither bee opened, nor fyl'd of, being of tempered steele, and as effectually locked as an iron chest." "It is difficult," writes Mr. Dircks, "to understand the intended use of this instrument, but it is more likely to have been suggested from a feeling of humanity than from any other motive. A desperate and ferocious enemy thus rendered helpless before being manacled would, assuredly, be less dangerous than he could otherwise be considered; and it would not therefore be requisite to take his life for personal safety; once thus secured he would be likely to listen to any terms of mercy." We entirely agree with the opinion expressed in this last sentence, but we cannot receive the explanation given of the intended object of this invention. Mr. Dirck's hero can apply his intellect to no ignoble purpose: "*a feeling of humanity,*" we call this a relic of Middle-Age barbarity; an instrument to be classed with the rack, the thumb-screw, and the spiked collar, worthy to have been used in the darkest and most gross period of the Spanish Inquisition; we think, moreover, that its invention or improvement in the 17th century, was an act unworthy of even a mediocre intellect.

Close upon this follow two inventions (89 and 90) which, in spite of what the commentator says on the subject, we can call neither more nor less than devices to enable one to cheat at cards and dice. The first is a mode of knotting silk in a pair of gloves in such a manner that "without suspicion," reckoning may be kept of all sixes, sevens, and aces, which a player at primero (an old game of cards) may have played. The second relates to a dice-box from which four false dice may be thrown out, while the real ones are at the same time fastened to the inside of the box.

Invention 26 relates to the raising of weights by leverage according to a method which the Marquis had seen in use in the Arsenal at Venice. Inventions 25, 27, and 99, refer to the raising or moving of a great weight through a certain space, by means of a small weight moving through an equal space. The commentator explains this by supposing the small weight to be represented by a piston moving air-tight in a cylinder, and that the great weight is moved by atmospheric pressure on the upper surface of the piston, a vacuum having previously been produced, by condensing steam beneath it. The explanation is ingenious, but we think far-fetched, for we have no reason whatever to suppose that the Marquis discovered the atmospheric engine.

We come now to the greatest of the inventions of the Marquis, the invention so often alluded to throughout this work; had all his other inventions been destroyed, this, according to his admiring biographer, would alone have rendered him immortal—we allude to the application of steam to the raising of water on a large scale. Inventions 68, 98, and 100 relate to this "water-commanding engine." We are bound to say that if the Marquis had invented and perfected the steam-engine as it now exists, he could not have spoken of his invention in higher terms: "I may boldly call it," he writes, "the *most stupendious work in the whole world;*" again he speaks of it as a "semi-omnipotent engine;" the introduction of *semi* we consider a great piece of modesty, when we compare the sentence with others on the same subject; "By Divine providence," he writes, "and heavenly inspiration, this is my stupendious water-commanding engine, boundless for height and quantity." In common with the other inventions mentioned in the 'Century,' this is described in very obscure language: it is defined as "an admirable and most forcible way to drive up water by fire, not by drawing or sucking it upwards, for that must be, as the philosopher calleth it, "intra sphæram activitatis, which is but such a distance . . . I have seen the water run like a constant fountain stream forty foot high; one vessel of water, rarefied by fire, driveth up forty of cold water, and a man that tends the work is but to turn two cocks, that one vessel of water being consumed, another begins to force and refill with cold water, and so successively, the fire being tended and kept constant, which the self-same person may likewise abundantly perform in the interim between the necessity of turning the said cocks."

The first application of steam as a motive power is mentioned by Hero of Alexandria, in his "Πνευματικα." A hollow sphere of metal, capable of free revolution, is furnished with two tubes, which issue from opposite points of its circumference, and are bent near their free extremity at a right angle; the sphere is partially filled with water, and heated; the steam issuing from the extremity of the tubes causes the sphere to revolve, on the principle of Barker's mill. Small working models of Hero's engine are to be seen in the windows of instrument makers; and an engine of this form has been patented, and is occasionally used, in the present day. From the time of Hero we hear nothing more of the application of steam till the beginning of the seventeenth century. In a work published about 1600, Hero's engine is recommended to be used for turning spits, its great advantage being that the partakers of the roasted meat may feel confident "that the haunch has not been pawed by the turnspit (in the absence of the housewife's eye), for the pleasure of licking his unclean fingers."

Hero mentions several devices for producing a fountain by means of compressed air. The apparatus he describes is exactly similar in construction to the compressed air fountain of the present day: a metallic vessel is provided with a tube, which reaches nearly to the bottom of it, and is terminated above by a jet capable of being opened or closed at pleasure. The vessel is partially filled with water, air is then condensed into it by a syringe; on opening the jet, water is forcibly ejected by the condensed air. In 1615, Solomon de Caus, a French engineer, describes and figures a fountain similar in form to that of Hero, but worked by steam instead of by condensed air. He writes as follows:—"Le troisième moyen de faire monter est par l'aide du feu, dont il se peut faire diverses machines; j'en donneray ici la démonstration d'une;" from which it would appear that this was not the first application of steam to the raising of water, although it is always quoted as such. We conceive that but little merit is due to De Caus, if indeed he devised this slight modification of Hero's fountain, which we think improbable. From the time of Hero (and probably long before), a jet of steam was employed in the place of ordinary bellows for blowing fires, water-air could, therefore, take the place of other air (indeed, it was generally believed that all airs were the same), what, then, could be simpler than to extend that replacement in other directions?

In 1628, Giovanni Branca, an Italian mathematician, produced rotatory motion by causing a jet of steam to impinge against the vanes of a wheel; the amount of motive power must have been very small.

We believe John Rey, a physician of Bugue, was the first to raise a piston by steam; in a work published in 1630, he describes a method for determining the volume of air produced from a known volume of water; for this purpose, he procured a hollow metallic cylinder, open at one end, and closed at the other, with the exception of an orifice, into which the beak of a small elopile could be fitted air-tight; a piston was forced down to the bottom of the cylinder, the elopile, full of water, was then fitted into its place, the water within it converted into steam, and the height to which the piston was raised carefully noted; by comparing the capacity of the cylinder below the piston with that of the elopile, the volume of air produced from a known volume of water could be readily calculated.

In 1630, a patent was granted to one David Ramsay, for an invention capable of being applied "to raise water from low pits by fire;" unfortunately, no description has been left of the invention.

We come now to the engine of the Marquis of Worcester, which appears (as far as one can judge from his very meagre and obscure description), to have raised water by a means similar to that employed by De Caus, *viz.* by the pressure of steam on the surface of water; but the Marquis had two water vessels, and perhaps a separate boiler for generating the steam employed: moreover, he obtained continuous action, and could raise large volumes of water. To him, therefore, belongs the merit of first applying steam to practical purposes on a large scale. Mr. Dircks has written much to prove that Savery's engine for raising water (a model of which was exhibited before the Royal Society in 1698) was the same as that of the Marquis; but we think he has pressed the point too far, for the Marquis, as we have seen above, expressly states that his engine raises water "not by drawing or sucking it upwards," whereas Savery raised water the first 30 feet by atmospheric pressure (the vacuum being produced by the condensation of steam), and then forced it higher by the pressure of steam. We do not think the engine of the Marquis was a perfect success, or it would have been more generally employed during the period intervening between its invention and the introduction of Savery's engine.

Mr. Dircks consummates all he has said of the 'Century of Inventions,' in the following sentence:—"The 'Century' stands alone in the languages of the civilized world, the strange monument of a strong mind, seeking its full development in a prejudiced age, striking into new paths which society could not comprehend, and which it therefore would not patronize." We would remind Mr. Dircks that in the 17th century it was not customary to describe scientific discoveries in obscure and unintelligible language; it was necessary to do so during the Middle Ages, when every kind of rank superstition was dominant, when a man who made a great discovery was believed to be in communication with the powers of darkness, and ran the risk of excommunication, or of being burned as a wizard, but there was no need for it now. The 'Century' is far more obscure than the "Πνευματικα" of Hero, published 1800 years earlier; it is more obscure than Porta's 'Magiæ Naturalis' (both of which works it resembles in certain respects): we know of no scientific work published in the 17th century of like obscurity, it reminds us most forcibly of some of the less intelligible of the writings of Roger Bacon. Compare it with the 'Sylva Sylvarum,' or, better, with the writings of Boyle and Hooke, and the contrast becomes striking: it would be unjust to compare it, either for its diction or for the inventions described in it, with the 'Micrographia;' the author of the latter work we do not hesitate to affirm did more to benefit the human race than the Marquis. He was a contemporary writer, a brother inventor, but his writings lack the obscurity and the bombast of those of the Marquis, and it cannot be denied that Hooke was the greater philosopher, and the greater mechanical genius of the two.

We cannot regard the Marquis of Worcester as "one of the most extraordinary mechanical geniuses of the 17th or any preceding century," as possessing "a mighty intellect," or the other exalted mental attributes with which Mr. Dircks endows him. How has the world profited by his labours, what benefits has it reaped from the 50,000*l.* which he declared he spent "in trying experiments and conclusions of art?" He was a schemer rather than an experimental philosopher. To take the subjects mentioned in the 'Century,' how many are utterly unworthy the attention of a great intellect, how many are perfectly useless! Moreover, they are, for the most part, not original inventions; we have previous mention of almost everything to which he alludes, and we can at most call them improvements upon, or modifications of, older inventions. The Marquis was not an original thinker, he worked up old ideas: had he written of the importance of his inventions with less bombast, we might have given him credit for knowing more than we can now do; as it is, we can but think that he often exaggerates, and strives to mystify and excite the wonderment of the world, rather than to describe inventions of utility to his fellow-men.

THE CONSTRUCTION AND USE OF THE ACHROMATIC MICROSCOPE.

THE title of this work * introduces it to the reader as an advertisement of Messrs. Smith and Beck's Microscopes, and there is no attempt whatever on the part of the author, a gentleman of considerable merit as a microscopist, to disguise the fact that it *is* an advertisement. If this had been all we have to say either for or against the book, it would have been left unsaid, for we have no wish to give undue prominence to the instruments, excellent though they be, of any particular manufacturer, to the detriment of any other, and whilst we are quite willing to accord due praise to Messrs. Smith and Beck for their efforts to improve the microscope, we cannot forget that Mr. Ross, Messrs. Powell and Lealand, Mr. Cooke, Mr. Pillischer, Messrs. Crouch, Mr. Collins, Mr. Ladd, and many others known to fame, are all making laudable exertions to improve and popularize the beautiful instrument, and all with marked success. But whilst we mention that Mr. Beck's book is published to advertise his instruments, and to explain their use and mechanism to those who may not be fully initiated in their employment, we have to deal with it also as a legitimate treatise on the microscope, for it is a work that will be found useful not only to those who possess an instrument made by the author's firm, but to every microscopist. It describes concisely, and, as it may be well supposed, accurately, the various parts of the instrument; gives excellent directions for practising different methods of illumination, by natural and artificial light; with the aid of the parabolic condenser and the "Lieberkuhn;" and describes the various forms, and the modes of employing the polariscope. The Binocular microscope, too, is treated at some length, and illustrations are given to exhibit its superiority over the simpler form of the instrument. The auxiliary appliances, such as the camera lucida, live-boxes, compressors, micrometers, lamps, dissecting instruments, mounting apparatus, &c. &c., are all described, and the whole subject is fully illustrated, so as to render any misunderstanding impossible.

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* 'A Treatise on the Construction, Proper Use, and Capabilities of Smith, Beck, and Beck's Achromatic Microscopes.' By Richard Beck. Van Voorst, 1865.

As for the illustrations, they are unique. The text occupies 134 pages, and the work contains 76 woodcuts and 27 plates, many of them well executed by the author himself, and all of the first order; some of the delineations of illuminated test-objects and polarized specimens equal in artistic beauty anything of the kind that we have seen.

Regarded as a treatise on the microscope and its uses, the work is, however, far from being complete, and we are sorry to perceive that the author has ministered so largely to the popular, and perhaps fascinating taste for diatom hunting. No doubt those organisms, "diatoms" and "desmids," form very suitable test-objects, and display the powers of a microscope to great advantage, but they create rather a love of display on the part of the owners of a good instrument than a desire to turn it to practical account, and we confess that we shall welcome the day when the *furore* for collecting diatoms has passed over. Then, when scores of amateurs have put their instruments (we had almost said their "playthings") on the shelf, medical men, chemists, physiologists, and micro-geologists, will be found to be the true patrons of the instrument, and microscope makers will (as some of them do already) recognize the truth that it is for the progress of science and to ameliorate the condition of the human race, that the use of the instrument has been revealed to man.

A remarkable omission, too, in the work before us, seems to be the absence of any mention of micro-photography, or of the apparatus employed in the development of this most interesting branch of microscopical science. If this omission is to be explained on the ground that the author's firm does not interest itself in the art, then, of course, it must be reckoned as one of the disadvantages of the work being an adjunct to their own labours only, but surely it would in no way injure them, and would materially increase the value of the book in a literary sense, if some details were added in a later edition concerning the application of the camera, and even of the spectroscope, to the instrument so ably described by the author.

Of the publisher's share in the work it is hardly necessary to speak. Mr. Van Voorst appears to be determined that whilst his name is linked with science, it shall add lustre to its efforts, and it is always with renewed pleasure that we take in hand a fresh volume from his workshop, our sole regret being that they are so few and far between as compared with former times.

We wish Mr. Beck a large circulation for his interesting work, and although it is published with a view to an increased demand for the instruments he seeks to recommend, this in nowise lessens its value in our estimation as a literary effort, and if successful, it will be doubly productive of benefit to microscopical science.

THE BATS OF NORTH AMERICA.*

BATS, "the onely bird that suckleth its little ones," in the quaint language of Holland, the translator of Pliny, exhibit the most complete modification of the mammalian form for flying purposes. For although there are flying lemurs (Galeopithecus), flying squirrels (Pteromys), and flying opossums (Petaurista), in all these cases the furred skin extends laterally from the sides of the body, and is attached to the anterior and posterior extremities of the metacarpal and metatarsal regions respectively, but is not associated with any especial osseous framework, such as is afforded by the elongated fingers of the bats. The bones of the Cheiroptera, too, do not communicate with the air, as do the bones of birds; but they are of extreme lightness and tenuity, the skeleton of the common brown bat of North America (V. subulatus) weighing only eleven grains. The skull, however, which in birds is light and toothless, is in bats large and rounded, containing from 30 to 38 teeth, usually four incisors in the upper and six in the lower jaw, canines, and molars which never exceed (true and false) six above and six below on either side. These differences in the number of the teeth form important characters in classification. To balance the weight of the head, there is great development of the ribs, sternum, and scapula, for the attachment of strong muscles of flight, as well as a long and strong clavicle. The senses of hearing and of touch are, in bats, remarkably developed, and each is accompanied by growths, which are very characteristic of the Cheiroptera, *viz.* the enormous ears, and the singular and grotesque leaf-like appendages situated upon the nose. The ears, both externally and internally, are highly perfected. The cochleæ are disproportionately large, as compared with the size of the semi-circular canals, the ampullæ very large; and to this osseous framework for the reception of sound, is added a complicated auricle, such as all insectivorous bats are provided with, and which is frequently larger than the head, and of a great variety of shapes, which are of great importance in classification.

The dermal growths of the nose are situated about the nostrils, and are either simple, upright, triangular folds of skin, or they may be exceedingly complicated in structure. No North American bat, with the exception of Macroticus Californicus, has such a development. These appendages are reduplications of skin, and are not related to the lining membrane of the nose, and it is doubtful whether they hold a definite relation to the olfactory sense. They are probably the agents for augmenting the sense of touch alone, and in this way act conjointly with the wing membranes, in which the sense of touch chiefly resides, and in which the papillæ of touch are extensively distributed. This function is, in many places, aided by the delicate hairs which are sparsely distributed upon the under-surface of the membranes.

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* 'Monograph of the Bats of North America.' By H. Allen, M.D., Assistant-Surgeon, U.S.A. (Smithsonian Miscellaneous Collections.)

The subjects of this monograph are animals which have scarcely met with their due share of attention, not that they are undeserving of notice, for few orders are more interesting; but their crepuscular and nocturnal habits render them difficult of observation. This fact is well illustrated by the history of British Bats. Gilbert White remarked in his day, "At present I know only *two* species of bats, the common V. murinus (the Vespertilio pipistrellus of recent authors), and V. (Plecotus) auribus." He himself added a third species to the list, and his editor, in 1835, enumerates seven species. In Bell's 'History of British Quadrupeds,' seventeen species are described, and others have since been recognized as inhabiting this country. It is worthy of remark, however, that of the seventeen species described by Bell, seven or eight have as yet only been represented by a single specimen, or taken in a single locality, a sufficient proof that we are in comparative ignorance of these animals; and that further research will infallibly be rewarded by the discovery of additional species.

The habits also of the known species are very imperfectly understood. The inaccessibility and dismal situation of their retreats, render it matter of great difficulty to secure them while hibernating; and it is only by sheer accident that they have been found under these circumstances. Opportunities, however, are occasionally offered to observe their flight and their habits of repose, by their accidental entrance into the open apartments of dwellings in warm weather, when they are readily caught, though they do not bear captivity well. They will then eat raw meat with avidity, but, curiously enough, refuse to partake of insects. They also lap up water eagerly; in fact, the first act of a bat, after emerging in the evening from his retreat, is to fly to the water.

The numerous parasites which infest bats constitute, perhaps, the most revolting feature in the history of these creatures. The enormous population of *acari* found upon their bodies is due to the great generation of animal heat in their close haunts, a condition conducive to the rapid increase of all kinds of vermin. In America the common bed-bug (Cimex lectularius) is frequently found upon their fur, and this is believed to be the cause of the introduction of this pest, in many instances, into homesteads from which general cleanliness would otherwise banish them. The immense number of some species may be judged from the fact that in a dismantled and uninhabited house in Maryland, there were found, when it came to be once more tenanted, myriads of a small black species of bat, which issued forth in clouds at the cry of the whip-poor-will to feed upon gnats and mosquitoes. Measures having been taken to rid the place of the pest, it was found by actual counting that nine thousand, six hundred and forty bats were destroyed in the main building. Their bodies were used as manure, but it required a term of five years to remove the very disagreeable odour that pervaded the building which they had inhabited in such numbers, and this was only effected by a copious use of disinfectants, and a thorough and prolonged ventilation of their holes.

Dr. Allen's memoir is an unpretending volume, published by the Smithsonian Institution, and is designed to exhibit the present state of knowledge of the Bats found in America, north of Mexico. It is based principally on the specimens in the museum of the Smithsonian Institution, although the collections of the Philadelphia Academy of Natural Sciences, and of the Museum of Comparative Zoology at Cambridge, Mass., have also been consulted. The work is illustrated with woodcuts, representing the head, and the skull, and teeth of each species, with enlarged figures of the ear, and generally also the form of the interfemoral membrane; and which contain therefore everything necessary for identification. The number of species described is not great, and does not exceed those known as inhabiting Britain, though of course the species are distinct. The twenty species are arranged in eight genera, of which only one, *Macrotus* (Californicus), possesses an upright appendage upon the nose; the genera Nyctinomus, Nycticejus, and Antrozous, contain each one species; Synotus, two; Lasiurus, three; Scotophilus, five; and Vespertilio, six species. There is but little which here calls for remark in regard to any particular species, inasmuch as they are scarcely so varied in their forms as those found in Britain; and information as to their habits is almost entirely wanting. The genus Synotus is chiefly noticeable for the enormous development of the ears, and the species *Nyctinomus nasutus* for its extraordinary geographical range, the author being confirmed by Mr. Tomes, as to the identity of the species in individuals taken in South America, Central America, South Carolina, and Hayti. The common American species appears to be the red bat (Lasiurus noveboracensis), which is universally distributed throughout the temperate regions in North America, and is moderately abundant. It has long and silky fur of a russet-red colour; fawn, fawn-red, and yellowish-cinereous varieties being met with—differences of hue which are chiefly owing to the coloration of the tips of the hair.

From the references which are given to the specimens contained in the Museum of the Smithsonian Institution, it would appear that all the twenty species described are well represented in that collection, and none (except *Vespertilio affinis*) are represented by only a single specimen. This is a new species, only once taken in Arkansas, and named by Dr. Allen. We should imagine it to be highly probable that the list of North American bats will, in course of time, be considerably augmented by new discoveries, and it seems not improbable that some of the various species described by Rafinesque, Leconte, De Beauvais, Temminck, Say, Audubon, &c., and referred to in the Appendix, may hereafter be rediscovered, and found to be distinct from any contained in the collections.

THE TREES AND SHRUBS OF THE ANCIENTS.

Dr. Daubeny, the distinguished Professor of Botany at Oxford, has just published an essay, on 'The Trees and Shrubs of the Ancients,' as a supplement to his valuable work on 'Roman Husbandry.'*

In the preface, he says:—"The late Professor Sibthorp, in founding a chair of Rural Economy to be attached to that of Botany already existing in the University of Oxford, directed that the holder of that office should deliver, each Term, a lecture on some one of the subjects which the Professorship in question might be regarded as embracing. In conformity with this regulation, I have, besides placing before my hearers from time to time the newest views on the theory of agriculture which modern science had developed, given occasionally such sketches of the husbandry of the ancients as could be gathered from the Scriptores Rei Rusticæ, whose writings have come down to us. The latter have since been embodied in a work published by me in 1857, entitled 'Lectures on Roman Husbandry,' in which I presented 'An Account of the System of Agriculture, of the Treatment of Domestic Animals, and of the Horticulture pursued in Ancient Times,' concluding with notices 'Of the Plants mentioned in Columella and Virgil.' To this publication, the present lectures may be regarded as supplementary, containing, as they do, a summary of the best information I have been able to collect as to the trees and shrubs really intended by those described or noticed in the principal Greek and Roman writers."

In writing the work, the author has availed himself of Sibthorp's 'Flora Græca,' Pliny's works, Sprengel's 'Historia Rei Herbariæ,' Fee's 'Flore de Théocrite,' and 'Flore de Virgile,' J. B. Du Molin's 'Flore Poétique Ancienne,' Billerbeck's 'Flora Classica,' Dierbach's 'Flora Apiciana,' Fraas' 'Synopsis Plantarum Floræ Classicæ,' and Lenz, 'Botanik der Alten Griechen und Römer.'

The book contains an identification of a greater number of Greek and Roman plants than is contained in any former English publication, and is a valuable contribution to our knowledge of the Classical Flora. He first treats of the trees producing fruit, acorns and resin. Many of the trees well adapted for the climate of Italy are traced, according to Pliny, to a foreign source. Amongst fruit trees, we are assured that the cherry, the peach, the quince, the damson, the jujube, the pomegranate, the apricot, the olive, and perhaps the vine were of foreign origin. The common fig was derived from Syria, and the sycamore fig from Egypt. Other fruits appear, like domestic animals, to have followed man in his migration. The orange was not introduced into Italy until the ninth century after Christ. The golden apples of the Hesperides, supposed to be oranges, seem rather to have been a variety of apple. The date palm had been introduced into

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* 'Essay on the Trees and Shrubs of the Ancients; being the substance of Four Lectures delivered before the University of Oxford, intended to be supplementary to those on "Roman Husbandry" already published.' By C. Daubeny, M.D., F.R.S., Professor of Botany and Rural Economy in the University of Oxford. Oxford and London: John Henry, and James Parker. 8vo. 1865. pp. 152.

Europe in Pliny's time. The following are supposed to be the species of oak known to the ancients :—

Quercus.

Fruits.	Leaves.	Ancient Names.	Modern Names.
Appearing the 1st year . . .	Deciduous .	Robur . .	Robur.
	,,	Esculus .	Esculus.
	Persistent .	Ilex . .	Ilex and coccifera.
	,,	Suber . .	Suber.
The 2nd year .	Deciduous .	Hemeris .	Toza.
	,,	Cerris . .	Cerris.
	Persistent .	Halephlæus .	Pseudo-suber?
	,,	Ægilops .	Ægilops.

And the following are the species of fir named by Pliny and Theophrastus :—

Leaves in pairs . .	Pinaster . .	Pinus halepensis, or maritima.
,, ,, . .	Tæda . .	,, mugho.
,, ,, . .	Picea . .	,, laricio.
,, ,, . .	Pinus . .	,, pinea.
Leaves in fives . .	Strobus? * .	,, cembra.
	Excelsa † .	
Solitary, Evergreen . .	Abies . .	Abies pectinata.
,, ,, . .	,, gallica .	,, excelsa.
Fascicled, deciduous .	Larix . .	Larix.

In the second lecture, the author considers the trees not included by Pliny under the head of Piciferæ, Cedar, Juniper, Citrus, Cupressus, and Taxus, as well as others, such as the lime, maple, thorn, ash, elm, alder, willow, poplar, birch, plane, &c.

In speaking of the Cedar of Lebanon, the author repeats an apocryphal story in regard to its introduction into the *Jardin des Plantes* from the Holy Land, in 1737, by Bernard de Jussieu. A romantic account is given of the difficulty this naturalist experienced in conveying it to France, owing to the tempestuous weather and contrary winds he experienced, which drove his vessel out of its course, and prolonged the voyage so much, that the water began to fail. All on board were consequently put upon short allowance; the crew, having to work, being allowed one glass of water daily, the passengers only half that quantity. Jussieu, from his attachment to botany, was induced to abridge even this small daily allowance, by sharing it with his plant, and by this heroic act of self-sacrifice, succeeded in keeping it alive till they reached Marseilles. Here, however, all his pains seemed likely to be thrown away, for as he had been driven, by want of a flower-pot, to plant it in his hat, he excited, on landing, the suspicion of the custom-house officers, who at first insisted on emptying the strange pot, to see whether any contraband goods were therein concealed. With much difficulty he prevailed upon them to spare his bantling, and succeeded in carrying it in triumph to Paris, where it flourished in the *Jardin des Plantes*, and grew until it reached 100 years of age, and 80 feet in height. In 1837 it was cut down to make room for a railway, and now the hissing steam engine passes over the place where it stood.

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* Only mentioned once by Pliny, lib. xii. 40, as used in fumigations. It seems rather rash to identify it, as Fraas has done, with the modern *Cembra*.

† Identified by Dr. Hooker with the *Pinus Peucè* of Griesbach, which that botanist had noted on Mount Peristeri, in Macedonia, and had considered as intermediate between *P. cembra* and *P. strobus*.

The P. excelsa, so common in the Himalayas, has not been observed nearer to Greece than Afghanistan, a distance of more than 2,200 miles.

We are astonished at this statement, and in commenting on it we give the following remarks of Dr. Asa Gray :—

"Of course, it is almost unnecessary to say that Bernard Jussieu never visited the Holy Land, and was not likely, if he had, to come home bare-headed, using his hat the while for a pot; that the fact, or at least the accepted tradition, is merely this, that he brought the seedling Cedar from *England* to Paris in his hat. The story of the voyage from the Levant to Marseilles appears to be an adaptation of one about the three Coffee-plants, which *Antoine* de Jussieu, in the year 1720, sent from the *Jardin des Plantes* to the vessel commanded by Captain Declieux, who was charged by the French Government with the duty of transporting them to Martinique. The voyage being unusually long, the water is said to have failed, two of the precious plants died, and the remaining one is said to have been kept alive by the devotion of the Captain, who bestowed upon it his own scanty ration of water, and so preserved the ancestor of all the Coffee-plantations of the Antilles. For this devotion, we presume, his name is commemorated in the genus *Declieuxia*, of the Coffee family. What are the other ingredients of this *pot-pourri* we are unable to conjecture. But the naturalists of the *Jardin des Plantes* may be somewhat astonished to learn that a railway traverses their peaceful grounds, and that a hissing steam engine runs over the steep little hill upon which flourished, and as we fondly imagine still flourishes, Bernard de Jussieu's Cedar of Lebanon."

The third and fourth lectures are devoted to various shrubby plants of Greece and Italy. In speaking of the Vine, Daubeny says :—"Some of the varieties of Vine described by ancient writers seem to exist at the present day—a fact worthy of notice with reference to the much-disputed question as to the dying-out of species. Thus Pliny notices a Greek Vine in a manner which would lead us to believe it meant for the Corinth or Currant of the Greek Islands. Columella also mentions that this variety of Vine was cultivated in several parts of Italy as well as of Greece; and Mr. Hogg states that it grows abundantly in the Island of Lipari, where it is called *Passolina*.

The engraving in the Vienna edition of Dioscorides will probably be considered as bearing more resemblance to the currant vine than to the ordinary one; and Dioscorides makes mention of two varieties, one probably the common *Vitis vinifera* in its wild state, the other the *Vitis labrusca*, with a woolly leaf, the parent, as it would seem, of the currant or Corinthian grape. I may add that, according to Count Odart, one variety of vine, now called *Pinceau*, was known so long ago as 1394. Another, planted in Andalusia by the Moors, still retains its characters; and that the *Cornichon* of Paris was described six centuries ago by an Arabian writer under the name of Lady's

Finger. A catalogue is given of the trees and shrubs indigenous in Greece and Italy, with the ancient Greek and Latin synonyms.

Dr. Daubeny remarks on the small progress made in natural knowledge between the period of Alexander and Trajan, a distance of time amounting to not less than 400 to 500 years. In accuracy of information, Theophrastus and Aristotle both greatly exceed Pliny, whose work, although invaluable as a Cyclopædia, bears evident marks of being a compilation, and not the result of original research.

"The Romans, indeed, seemed to have acted towards the Greeks as our Mediæval writers did towards the Ancients, and instead of observing for themselves, were contented with copying from preceding authors, whose statements had with them the force and authority of ocular demonstration. Thus there is often a remarkable similarity between the descriptions of plants given by Pliny and Dioscorides, showing either that one copied from the other, or that both derived their information from some common source. Yet neither writer ever alludes to the other. The works of Columella, too, are, in most respects, an amplification in more elegant Latinity of the earlier writings of Cato and Varro, and very possibly the two latter would have been found to be taken from the great Carthaginian work 'On Agriculture,' by Mago, if the latter had come down to us. How mortifying it is to think, that whilst these repetitions of facts, and even of old fables, recorded by many of the authors referred to, might have been so well spared, we should have to deplore such gaps in the history and literature of antiquity as have arisen from the loss of many of the books of Livy, and from the almost entire destruction of the Comedies of Menander and Epicharmus."

Dr. Daubeny's work is one of much interest, and is valuable not merely to the Botanist, but to the Philologist and Antiquarian. We recommend it as containing information which cannot easily be procured elsewhere.

SCIENTIFIC ASCENTS OF MONT BLANC.

CHARLES MARTINS gives a notice of two scientific ascents of Mont Blanc.* He describes, in the first place, the ascent of Horace Benedict de Saussure in 1787, and gives full details of the results of his labours. This first grand scientific ascent has served as the model of all others. During a space of fifty-seven years, from 1787 to 1843, there were twenty-seven ascents of Mont Blanc; but none of these were of a truly scientific character. A noble curiosity—a desire to visit the world of snow and ice, and to enjoy from the summit of Mont Blanc one of the grandest views which man can contemplate; such were the motives by which the greater part of travellers were actuated. Nevertheless several travellers published some interesting scientific facts as the results of their ascents. We may notice specially that of Francis Clissold on 18th August, 1822. That of Marckham Sherwill on 26th August, 1825; of Auldjo, on 9th August, 1827; and of Dr. Martin-Barry. Since 1844 the ascents have been numerous, and at the end of 1863 the actual number has risen to 171, of which three were made in June, thirty-six in July, eighty-four in August, forty-seven in September, and one in October. The extreme dates are 1st June, 1858, the ascent of J. Walford; and the 9th October, 1834, the ascent of M. de Tilly, who came back with his feet frozen, and suffered for a long time from this rash attempt at an advanced period of the year.

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* 'Deux Ascensions Scientifiques au Mont-Blanc, leurs résultats immédiats pour la Météorologie, la Physique du Globe et les Sciences Naturelles.' Par Charles Martins, Professeur d'Histoire Naturelle à la Faculté de Médecine de Montpellier. 8vo. Paris, 1865. pp. 38.

The author then gives an account of a scientific ascent made by himself in 1844, with his friends Auguste Bravais, a naval lieutenant, and Auguste Lepileur, a doctor of medicine. With the former he had visited Spitzbergen in 1838 and 1839, and had sojourned on the Faulhorn, in 1841, for eighteen days, at the height of 2,680 metres above the level of the sea. Minute details are given of the preparations made and of the various phenomena observed. The following are the plants noticed on the Grands Mulets:—Draba fladnizensis, Wulf.; D. frigida, Gaud; Cardamine bellidifolia, L.; C. resedifolia, Saut.; Silene acaulis, L.; Potentilla frigida, Vill.; Phyteuma hemisphericum, L.; Pyrethrum alpinum, Willd; Erigeron uniflorus, L.; Saxifraga bryoides, L.; S. groenlandica, L.; S. muscoides, Auct.; S. oppositifolia, L.; Androsace helvetica, Gaud; A. pubescens, DC.; Gentiana verna, L.; Luzula spicata, DC.; Festuca Halleri, Vill.; Poa laxa, Hæncke; P. cæsia, Sm.; P. alpina var. vivipara, L.; Trisetum subspicatum, Pal. Beauv; Agrestis rupestris, All.; Carex nigra, All.

M. Martins gives interesting details of the adventures which he and his friends encountered, and of their scientific researches into the oscillations of the barometer and of the thermometer, the relative humidity of the air at different hours of the day, the temperature of the soil at different depths, the nocturnal radiation of the surface of the snow, the plants and animals observed, the measuring of the proper heat of the sun's rays, the phenomena of glaciers and the physiological effects manifested in the human body. The work is one of much interest, and will fully repay an attentive perusal.

MISCELLANEOUS BOTANICAL WORKS.

Flora Capensis.

The third volume of the 'Flora Capensis,' by Harvey and Sonder has been recently published.* It embraces the Orders from Rubiaceæ to Campanulaceæ, or those Orders of Calyciforæ, which have a gamopetalous corolla and an inferior ovary. The work is one of the Colonial Floras, which we owe in great measure to the representations of Sir William J. Hooker. It is executed by Botanists of great reputation, who have personally studied the South African Flora during their residence at the Cape of Good Hope. The fourth volume is now in preparation, and will include the proper Corollifloral Orders, with superior ovaries. The fifth volume will take in all the Monochlamydeæ, and the sixth the Monocotyledons and Ferns, completing the work. The following are some of the remarks in the preface:— "In undertaking the Flora Capensis, the authors propose to furnish to the colonists in the British South African provinces a clear and concise descriptive catalogue of the vegetable productions of their adopted country. As the colonies have no very definite limits to the northward, neither have the authors been anxious to fix a boundary line to this Flora. Generally speaking, the Cape Flora is limited on the north by the Gariep or Orange River, and on the east by the Tugela—boundaries more convenient than natural, for the Orange River, at its western extremity, rather flows through than bounds the peculiar Desert Flora of Namaqualand; and the Tugela merely limits the British Colony of Natal, while the characteristic vegetation of Kafferland, of which Natal is a section, extends northwards at least to Delagoa Bay, gradually assuming the features of Tropical African vegetation. Whilst, therefore, the Flora is tolerably complete for the old-established colonial district, both of the Western and Eastern provinces, it presents little more than an outline sketch of the Northern and North-Eastern regions, and of the Natal Colony; and still more imperfectly portrays the vegetation of Great Namaqualand, Betchuanaland, the Orange River Free State, and the Transvaal Republic, all lying beyond the Gariep.

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* 'Flora Capensis; being a Systematic Description of the Plants of Cape Colony, Caffraria, and Port Natal.' By W. H. Harvey, Professor of Botany, Trin. Col., Dublin, and Otto W. Sonder, Ph.D., of Hamburg. 3 vols. 8vo. Dublin: Hodges, Smith, & Co.

"The authors have diligently availed themselves of every accessible collection of plants from the last-named regions; but so few botanical travellers have yet explored them, save in some scattered spots, that their vegetation is as yet all but unknown. From what we know of the plants of Transvaal, especially of its mountains and high plateaux, that country promises to the Botanist the richest harvest yet ungathered in South Africa, and the long mountain range that divides Kaffraria from the Western regions, while it limits the distribution of the greater portion of the subtropical types that mingle in the Cape Flora, probably still retains in its unexplored wilds multitudes of interesting plants. This we infer from the fact that almost every small package of specimens received from the Natal, or the Transvaal district, contains not only new species but new genera; and some of the latter are of so marked and isolated a character, as to lead us to infer the existence in the same region of unknown types that may better connect them with genera or orders already known."

The work is one of vast importance as regards practical and Geographical Botany, and it is the only good work of reference in connection with the Cape Flora. It must be in the library of every Botanist who wishes to study the plants of Southern Africa.

BRITISH FLOWERING PLANTS AND FERNS.*

Professor Henslow was one of the first to publish a list of British plants, with the view of facilitating exchange of plants. He was succeeded in this by the Botanical Society of Edinburgh, which was instituted by students in the year 1836. The Society while it held meetings for the reading of papers, also made large collections of plants for the purposes of exchange. This practice had been long carried on by Edinburgh Botanists, in reference to their private Herbaria, but the Botanical Society took it up on an extended scale. Its members contributed largely—some of them giving between 3,000 and 4,000 specimens to the general stock in one season. Upwards of 100 members contributed, and the distribution of specimens required the united labours of many zealous office-bearers. Rooms in the University of Edinburgh were placed at their disposal, through the kindness of Dr. Graham, the Professor of Botany. By this means a large number of British and foreign species were very widely circulated. The Society still carries on the distribution of specimens, but on a more limited scale. In order to effect exchange it was necessary to have a catalogue of British plants, on which members could mark their desiderata. Accordingly in 1836 such a list was published, and was very extensively circulated. It was arranged according to an alphabetical method, and contained of flowering plants and ferns 521 genera, 1,636 species, and 149 varieties. It also gave information relative to the occurrence of plants within sixteen miles of Edinburgh. The Edinburgh Flora reckoned 715 species and 18 varieties.

A second edition was published in 1841, and contained 545 genera, 1,649 species, and 239 varieties. A third edition, in 1851, contained 565 genera, 1,715 species, and 352 varieties. The present is the fourth edition and contains 568 genera, 1,817 species, and 369 varieties. It is more complete than the former, and indeed is the most perfect catalogue at present in Britain. It has been arranged according to the natural method, and an alphabetical index of genera is added with references to the pages in which the species are to be found.

In addition to the usual list of British plants, the present edition of the catalogue gives, in an Appendix, a full list of the varieties of British ferns, drawn up Mr. P. Neill Fraser. This is a useful list for those who are fern fanciers, and who wish to collect the numerous abnormal forms presented by ferns, whether in a native or a cultivated state.

We look upon this as the best list of the British Flora which has been published, and we consider it well fitted for botanists who desire to keep a record of the plants in their Herbaria, and to send notice of their desiderata to the Botanical Society, or to plant Exchanging Clubs. The following plants, among others, are introduced:—Hutchinsia alpina, Viola arenaria, Rosa Bakeri, Pyrus rupicola, Amm majus, Galinsoga parviflora, Acanthus mollis, Neotinea intacta, Demazeria sicula, &c.

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* 'Catalogue of British Plants, including the Flowering Plants, Ferns, and Characeæ; to which is appended a list of the varieties of British Ferns.' Fourth Edition. Small 8vo. pp. 43. Printed for the Botanical Society of Edinburgh. Edinburgh: Adam and Charles Black. London: Longman, Green, Longman, Roberts, and Green.

HOT-HOUSE FLORA.

The excellent periodical, known as 'Flore des Serres,'* published at Ghent by Louis Van Houtte, continues to maintain its reputation. It embraces a consideration of all that concerns gardening with reference to usefulness or ornament; the culture of plants in stoves and in the open air; the cultivation of pot-herbs, and of fruit and forest-trees; the description of plants recently introduced into gardens; the examination of questions on Natural History, Meteorology, and General Physics, connected with Horticulture; as well as an account of travels. Each number contains several well-executed coloured plates. In the present number there are figures of Aplotaxis gossypina, a composite plant of the Himalaya, covered with a dense coating of hairs. Dischidia Rafflesiana, an Asclepidaceous plant of Malacca and Singapore, remarkable for its pitcher-like appendages; Maximowiczia chinensis, one of the Schizandraceæ from the Amur district; Phœnicophorium sechellarum, and Verschaffeltia splendida, palms from the Seychelles Islands. The scenery in connection with some of the plants is well portrayed in the coloured drawings. The work does great credit to the editor and to the artist.

MUSCOLOGY.

The mosses peculiar to Eastern North America have been investigated by Dr. William S. Sullivant, and he has published a work on the subject.† It contains excellent delineations of the mosses with full descriptions, and constitutes a valuable contribution to the muscology of North America. Being entirely of a descriptive character, it is impossible in this notice to give anything like an abstract of the publication. To the practical Botanist who is studying the American mosses, the work is invaluable.

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* 'Flore des Serres et des Jardins de l'Europe, Journal Général d'Horticulture.' Tom. xv. livr. ii., 20 Mai, 1865.

† 'Icones Muscorum; or, Figures and Descriptions of most of those Mosses peculiar to Eastern North America which have not been hitherto figured.' By Wm. S. Sullivant, LL.D., &c. With 129 Copper-plates. Cambridge, Massachusetts. 1864.

PAMPHLET.

BENEFICENCE IN DISEASE.*

DISCARDING the view, long held by all classes of thinkers, that diseases are to be "looked upon in the light of scourges," the author of this pamphlet assumes that they form part of the scheme of Nature for maintaining or restoring the healthy condition of the human race, and he sets out with the inquiry: "What purpose does disease answer in the great scheme of Nature?"

He shows that disease is always preceded by some local or general injury, and that it is the visible effort of Nature to save the subject of the injury from more serious consequences, in fact, as we understand it, from some permanent derangement of a portion of the body or from death. Seeking his illustrations in aural surgery, that branch of the healing art with which he is the best acquainted, Mr. Toynbee tells us that the disease known as Otorrhœa often arises from some violence done to the ear, such as a blow or a prick; or from gout, scrofula, or a general disorder which attacks the ear when that organ is rendered unusually susceptible of attack by some trivial injury, such as a "box on the ear." His meaning will be more fully explained hereafter.

And need there be any doubt as to the correctness of his views, when they are tested by the more extended experience of the human physiologist, or by that of the moralist? In another place † it has been shown that those diseases which have always been considered *par excellence* the scourges sent to punish man—plague, fever, &c.—are the results of injuries inflicted upon society through the neglect of the simplest and best known sanitary laws; and just as gout, or scrofula, is shown by the author to find its expression in Otorrhœa, and when the general injury (gout) is removed, the special disease (Otorrhœa) disappears or is easily cured, so in the larger case where filth, overcrowding, and drunkenness, the general injuries inflicted on society, find their issues in plague and fever, these disappear or are easily combated when houses are ventilated, and the inhabitants become sober, moral, and cleanly, and live in conformity with sanitary laws.

But the author need not even have limited the application of his principle to the *physical* condition of man; for, this being intimately allied to his moral state, the application of the law he enunciates necessarily extends to that also.

If we were to follow the career of a youth who gives himself up to dissipation, we should find that not only is each successive form of disease the means by which Nature seeks to rid the body of some "general injury," some poison that circulates through the system, but

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[*] 'Beneficence in Disease: being an Introductory Address, delivered at the opening of St. Mary's Hospital Medical School, October 1, 1864.' By Joseph Toynbee, F.R.S., &c. Churchill.

[†] 'On the Predisposing Causes of Pestilence.' Second article in the present Number.

that the infliction itself is reformatory, and cannot in any way be regarded as a scourge. The remorse, and the resolution to reform, sometimes carried out, and at others broken on the recovery of the patient, combine with the physical result of the disease itself to exhibit in a most striking manner the full meaning of the author's title, 'Beneficence in Disease.' If the lesson has been without effect, and the patient returns to the poisoned fountain, inducing successive diseases which at length put an end to his life, it cannot be said that he has been condemned to death by disease, but rather, on the view expressed by Mr. Toynbee, that the general injuries which the sufferer has inflicted upon himself have been so serious as to prevent the visible disease from serving any longer as a corrective, and that he has succeeded in spite of natural safeguards in putting an end to his earthly existence.

Returning to the pamphlet before us, we find the reparative action of disease exhibited in cases which have come under the author's immediate notice; and as they are interesting illustrations of the principle he enunciates, we will extract a few of them for the perusal of our readers:—

> "*Case* 2.—A gentleman hunting galloped along a green lane through a wood, and a twig of an overhanging beech-tree penetrated the tube of the left ear and lacerated the drum. Inflammation and suppuration and catarrh of the dermoid layer followed; another form of disease usually called otorrhœa, thus presented itself; after a short time, however, the aperture healed, and the hearing was restored.
>
> "*Case* 2*a*.—A young gentlemen of scrofulous diathesis received from his tutor an unexpected box on the ear. As is not unfrequent, when unexpectedly concussed, the drum was ruptured, pus was soon effused, and what would formerly have been called a troublesome case of otorrhœa set in. For instead of the orifice of the drum healing, as in the former case, the discharge continued for months, and the affection was but slightly influenced by treatment, until the scrofulous tendency had been overcome by general means: then, under the use of local remedies, the healthy state of the drum was gradually restored.
>
> "In these two cases, the reparative character of the disease was, I think, manifest. In the first case the injury to the drum alone had to be repaired; in the second, the injury which the system had suffered likewise demanded repair.
>
> "I will cite two more illustrative cases.
>
> "*Case* 3.—A gentleman, riding at a gate, was carried by the swerve of his horse against a high hedge; pain in the right ear followed and continued to increase for three or four days, although leeches, fomentations, and blisters were resorted to. When called in about the seventh day, I found the dermis much swollen, at its middle part, where a small black point was seen in the centre of the mass. I removed the black speck, which proved to be a thorn, and the patient was speedily well.
>
> "*Case* 3*a*.—A scrofulous lady, who was much out of health, when picking her ear, let a pin fall into the meatus; during attempts at its removal, the point of the pin was pulled by a pair of forceps into the substance of the meatus and there left. Inflammation and suppuration round the end of the pin followed, as in the preceding case, but it extended to the mucous membrane of the tympanum, thence to the membranes of the brain, and caused death.

"In these two cases again, the inflammation and suppuration were palpably for the purpose of removing the foreign bodies. In the first case they were almost successful without the aid of art; in the second, the attempt at the removal of the local injury, which in itself was perfectly adapted to its end, could not succeed because the general injury under which the system laboured, in the form of scrofula, demanded for its relief another and more extensive process, for which the weakened organ to which it was determined afforded insufficient scope. Death accordingly ensued; but death which arose strictly from a struggle towards repair."

The author warmly contests the opinion expressed by Sir John Forbes, that the object of disease is to arrest or destroy life, holding that it would be inconsistent with what we know of the ways of the Creator, that having given to man life with its marvellous attributes, He should send disease to take that life away. We cordially sympathize with Mr. Toynbee in his view of the reparative character of disease, and although he limits his exposition of the law to those forms of it which have presented themselves in the branch of hygiene in which he holds so eminent a rank, we feel convinced that the day is not far distant when its curative and reformatory character will be universally acknowledged, and when that which is now regarded as the disease will be looked upon in a new light, and the disease proper will be sought in what are now considered its predisposing causes.

We cordially commend the little pamphlet to the notice of our readers. It does credit to the head and heart of its author; the statements put forth in it appear to us clear and convincing, and the views enunciated are not only consistent with the dictates of common sense, but they are in conformity with those of the most advanced physiologists, and present another link in the chain of evidence which establishes the unity of design and action pervading the visible operations of Nature.

NOTES AND CORRESPONDENCE.

On the Cerebrum of the Entellus Monkey. (Semnopithecus Entellus).

By E. Ray Lankester.

The important discussions which have been going on during the last two or three years, relative to the comparative relations of the brains of man and the higher monkeys, have excited so much interest, that a few remarks on the cerebral conformation of an animal holding a comparatively high position in the quadrumanous series, may not be altogether unacceptable to the readers of this Journal.

About a year since, I received from the menagerie of the Zoological Society, by the kindness of the secretary, the Entellus monkey, which had recently died. With regard to the anatomy of the other parts of the body, no mention need be made; the brain was carefully exposed by removing the calvarium, and drawings and observations were made. It was then placed in spirits and allowed to harden for several months. The following description of the cerebrum of the Entellus is given from careful examination of this specimen; at the same time, I would distinctly state that in all material points as well as matters of detail, I have only to confirm the observations of that accurate and lamented anatomist, M. Pierre Gratiolet. I have, however, been able to make an examination of the internal modifications of structure in the brain of Semnopithecus, which M. Gratiolet did not consider himself justified in doing with the few specimens preserved in the Museum of the Jardin des Plantes.

From a careful study of the form and arrangement of the cerebral folds and convolutions in the higher quadrumana, M. Gratiolet came to the conclusion that the Orang, the Chimpanzee, and probably also the Gorilla, were almost equally closely related to man, and that they each formed the culminating point of a series having more or less the same peculiarities in brain structure. Beneath the Orang are placed the Gibbons (Hylobates), followed by the Semnopitheci and Cercopitheci, the series thus merging into the smaller monkeys; with the Chimpanzee, in the same way, he associates the Macaci, Rhesus, and Magots, while he conjectures that the Gorilla would form the highest development of a similar series, including the Baboons (Cynocephali, &c.) It will be seen, therefore, that the brain of the Semnopithecus is only three degrees removed from that of man, and holds a position intermediate between that of the Gibbons and the Cercopitheci. The truth of M. Gratiolet's propositions with regard to the three types of arrangement of the cerebral convolutions cannot be doubted by any one who examines his drawings; it would no doubt be interesting to follow out his line of argument, and to see on what grounds the brain of the Semnopithecus has this position assigned to it; but all that I can here do is to examine whether the specimen about to be described furnishes any additional evidence of value by the characters of its internal structure or external conformation, tending to confirm M. Gratiolet's statements.

The general form of the brain of the Entellus, as seen in Fig. 1, is a very regular, rather broad, oval; when viewed thus in the skull after the removal of the calvarium, *no portion* of the cerebellum is visible, the cerebrum *completely covers it* and *overlaps* it to an easily appreciable extent. The convolutions of the upper face are drawn in Fig. 1. It will be observed that the two hemispheres are nearly symmetrical with regard to the disposition of the sulci, though not completely so. I found, however, that in my specimen the differences between the two hemispheres were identical with those given by Gratiolet in his figure. The parts lettered *a*, *b*, *c*, are the three portions of the frontal region, respectively inferior, middle, and superior. The large development of the superior frontal region is a sign of elevation in monkeys—as the greater comparative size of this part of the brain in man is one of the chief points of difference between him and the higher apes. The Orangs, Gibbons, and Semnopitheci, have this portion of the brain developed to a greater extent than the series formed by the Chimpanzee, Macaci, &c., and hence, perhaps, the Orang should be placed nearer to man than the Chimpanzee, while the Semnopithecus would hold a higher place than the corresponding forms in the other series. The parts marked *d*, *e*, *e′*, *f*, form the parietal region of the brain, *d* being "the first ascending convolution," *e* "the second," *e′* "the lobe of the second ascendiug convolution," and *f* "the curved convolution." The fissure separating the curved convolution from the lobe of the second ascending convolution is well marked in the Entellus, and is immediately connected with the deep incision which separates the parietal from the occipital region *i*, *j*. In the sketch, only the superior and middle portions of the occipital region are visible; its inferior portion is situated below, and is partially seen in the lateral view of the internal face (Fig. 2).

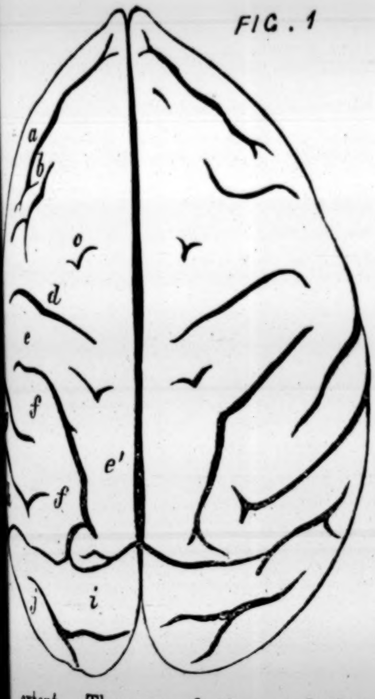


FIG. 1

Above the letter *g* in Fig. 1, which marks the inferior marginal convolution, is the fissure of Sylvius, separating the tempero-sphenoidal region of the brain from the parietal. In the Semnopitheci the fissure of Sylvius is free and open throughout; in the allied Cercopitheci its summit is hidden under the folded convolution *f*. The middle temporal convolution *h*, and the inferior marginal *g* are all that are visible of the tempero-sphenoidal lobe on the superior surface.

The principal fact which is observable on comparing the brain of this monkey with the drawings and descriptions of the brains of Gibbons and Cercopitheci, is that in the Semnopithecus there is a development of the frontal region intermediate between what is observable in these two: as Gratiolet says "the frontal lobe is advanced towards the posterior parts of the brain; the anterior region is developed at the expense of the posterior;" thus indicating an advance on the brain of the Cercopithecus, but not reaching to that of the Gibbon. The folded convolution *f* is not sharp, as in the Cercopitheci, but is less elevated, and describes a rounded curve; its descending branch is larger and thicker at its root, which becomes developed, and presents a feeble, but distinct swelling. The fissure of Sylvius and its marginal folds, in consequence of this increased anterior development of the cerebrum, present an increased angle, whilst the occipital lobe is much reduced, two deep fissures dividing its superior and middle portions. The superior connecting convolution (*pli de passage*) in Semnopithecus is largely developed and entirely superficial, and in consequence of the fissure being obliterated the operculum is not developed at its superior part. The second connecting convolution is not obvious.

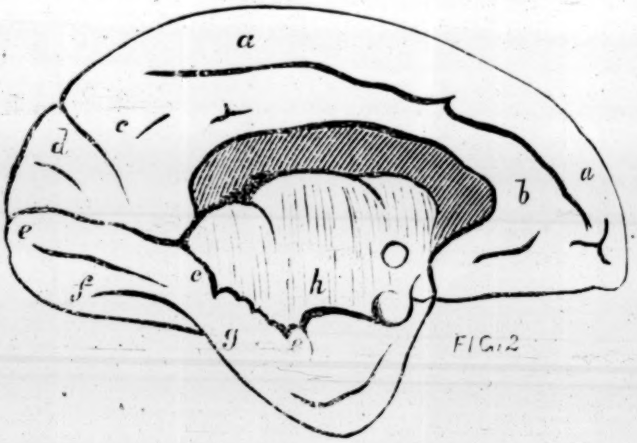
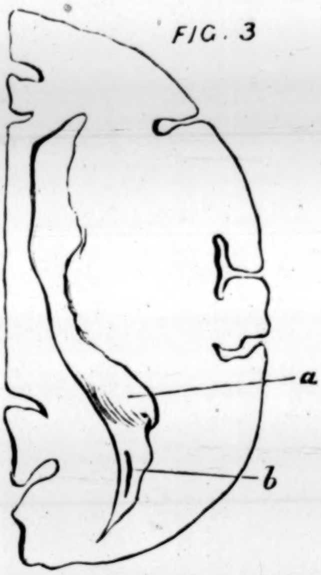


FIG. 2

M. Gratiolet was unable to examine the internal face of the cerebral hemisphere in the Semnopitheci on account of the specimens he had at hand being few in number. I have opened the brain in my possession, and an outline of its internal folds and fissures is given in Fig. 2: *a* is the convolution of the external zone divided by a deep fissure from *b*, the convolution of the internal zone, and *c*, the quadrilateral lobe; *d* is the internal occipital lobule; *e* the fissures of the hippocampi; *f* the inferior temporal fold, and *g*, the middle internal temporal fold; *h* is the "pli godronné." The quadrilateral lobe is of larger size than in the Cercopitheci; the occipital lobule is smaller, and the fissures of the hippocampi are much simpler and straighter. There is also about the posterior surface a greater freedom from plication, and a more definite separation of the occipital lobule and temporal folds than in the Cercopitheci. Now from his extensive researches on the cerebral anatomy of Quadrumana, M. Gratiolet has been led to lay down the following law: That the higher a monkey is in the series leading up to man, the larger will be the development of the quadrilateral lobe, and the greater the simplicity of the fissures of the hippocampi, and *vice versâ.* Hence the examination of the internal surface of the cerebral hemispheres of Semnopithecus confirms their position above Cercopithecus; since it shows that they present characters entirely coinciding with M. Gratiolet's statement deduced from the study of other brains. It may be well here to give the external characters also, which according to M. Gratiolet's most trustworthy deductions, determine the relative position of a brain in the simious series. The characters of an elevated brain are: 1st, the large size of the frontal lobe, particularly of its superior portion; 2nd, the large size of the lobule of the second ascending convolution, and the simultaneous development of all the external connecting convolutions; also the reduction of the ascending roots of the ascending convolutions; and the diminution of the ascending branch of the curved convolution. The small size of the occipital lobe and of the marginal convolutions are in all monkeys to be regarded as signs of elevation.

With regard to the lateral ventricles, I may observe that by carefully removing the brain tissue they were exposed (as in Fig. 3); both anterior and posterior cornu were well developed, and the hippocampus major *a* was sufficiently obvious, while a small protuberance on the inner wall of the posterior cornu was noted, which may undoubtedly be regarded as the homologue of the much canvassed hippocampus minor. The ventricles were shallower, and their parts less defined than in higher monkeys, but it was not difficult to ascertain the homologous parts.

FIG. 3



E. Ray Lankester.

Downing College, Cambridge,
June, 1865.

The Sahara and the North-East Trade Wind. By W. Pengelly, F.R.S., F.G.S., &c.

The exigencies of time and space forbid me, on the present occasion, to take up *all* the questions raised by the Rev. H. J. Ward's note "On the Connection between the supposed Inland Sea of the Sahara and the Glacial Epoch," which appeared in the last (the April) Number of the 'Quarterly Journal of Science.' There is one point, however, to which I may be permitted to call attention. Mr. Ward believes that to the question "What causes the N.E. Trade-wind?" most geographers will reply without hesitation, "Mainly the Sahara" (p. 357).—Again, he says, at p. 358, "Suppose the Sahara then, to be an expanse, not of *sand*, as now, but, as formerly, of *water*; what would be the results?

* * * * *

The trade-wind would cease, or be so reduced in strength as to exert but slight pressure on the surface of the Atlantic."

Let it be granted that the Sahara is more heated than the land and water surrounding and near it; it will follow that its atmosphere will be expanded, diminished in weight, will ascend, and thereby produce a vacuum, into which, under normal conditions, the air from *all* sides will flow. That on its eastern margin will acquire an apparently westerly motion, and that on the west will move in a relatively easterly direction; — correctly, the easterly motion which the atmosphere possesses in consequence of the earth's rotation will be diminished in the first case and augmented in the second. But of the currents whose initial movements are in a meridional direction, that on the north will successively reach parallels moving more and more rapidly eastward, and, by lagging behind, will, by the parallelogram of motion, move relatively from between the north and east; whilst, from the reversal of conditions, the current from the south will have an apparent motion from the south-west. Instead, therefore, of being mainly the cause of the north-east trade-wind, the Sahara must have a tendency to produce a westerly wind on its Atlantic margin; and this is borne out by the facts of the case. (See 'Penny Cyclopædia,' art. "Atlantic," vol. iii. p. 27; and Captain Basil Hall's 'Fragments of Voyages,' second series, chap. vii.)

The Sahara, therefore, consistently employs its great power to destroy the uniformity of the trade-wind; let it be submerged, and the westerly winds which now prevail between Cape Bojador and the mouth of the Senegal will disappear with it, and the N.E. trades will receive an accession of territory and probably of intensity.

If it were true that the Sahara mainly causes the N.E. trade-wind, or increases its strength, the heated land of India, during the interval between the spring and autumnal equinoxes, should augment the force and confirm the uniformity of the north-east trade of the Indian Ocean; instead of which it not only strangles it, but actually sets up a rival in the form of the south-west monsoon. In fact, it produces an effect which only differs from that caused by the Sahara on the Atlantic bordering the north-west of Africa, in being periodical while the latter is permanent.

Assuming, therefore, that during the submergence of the Sahara the Atlantic was, as now, an open ocean, the north-east trade wind would prevail over a larger area than at present; its force would probably be greater: the Gulf Stream would consequently be of somewhat greater volume, or velocity, or both; and its effect would be to that extent even more anti-glacial than it is under existing conditions.

W. Pengelly.

Lamorna, Torquay,
May 1, 1865.

Books received for Review.

From *Messrs. Longman & Co.:—*

SATURN AND ITS SYSTEM. By Richard A. Proctor, B.A., late Scholar of St. John's College, Cambridge. 260 pp. 8vo. 14 Plates.

A DICTIONARY OF SCIENCE, LITERATURE, AND ART: comprising the Definitions and Derivations of the Scientific Terms in General Use, together with the History and Descriptions of the Scientific Principles of nearly every Branch of Human Knowledge. Edited by W. T. Brande, D.C.L., F.R.S., and the Rev. Geo. W. Cox., M.A. Parts I. to III.

ON RADIATION. By John Tyndall, F.R.S. 62 pp. Post 8vo.

THE "FLINT IMPLEMENTS" FROM DRIFT, not authentic. Beinga Reply to the Geological Evidences of the Antiquity of Man. By Nicholas Whitley.

MAN, CONSIDERED SOCIALLY AND MORALLY. By George Sparkes, late Madras Civil Service. 165 pp. Fcap. 8vo.

STAMMERING AND STUTTERING: their Nature and Treatment. By James Hunt, Ph.D., F.R.S. Sixth edition. 260 pp. Post 8vo.

From *Messrs. J. Churchill & Sons:—*

ASTRONOMICAL INVESTIGATIONS: The Cosmical Relations of the Revolution of the Lunar Apsides. Oceanic Tides. By Henry F. A. Pratt, M.D. With Engravings. 90 pp. 8vo.

NITROGEN SHOWN TO BE CARBONIC OXIDE IN AN ALLOTROPIC STATE. By Henry Kilgour. 30 pp. Demy 8vo.

From *Messrs. Smith, Elder, & Co.:—*

METEOROLOGY AND THE LAWS OF STORMS: being a New Theory of the Causes of Winds, and an Investigation of the Nature of Storms, concluding with Practical Rules for their Avoidance. By Geo. A. De Penning, C.E. 15 Plates. 100 pp. Demy 8vo.

From *Messrs. McMillan & Co.:—*

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LETTERS ON THE SUBJECT OF THE UTILIZATION OF THE METROPOLITAN SEWAGE, addressed to the Lord Mayor of London, by Baron Liebig. With the Reports of the Coal and Corn and Finance Committees of the Court of Common Council. 44 pp. 8vo.

From *Mr. Skeffington:*

THE PHENOMENA OF RADIATION, AS EXEMPLIFYING THE WISDOM AND BENEFICENCE OF GOD. By George Warington, F.C.S. 190 pp. 12mo.

From *the Authors:—*

ESSAY ON THE TREES AND SHRUBS OF THE ANCIENTS: being the Substance of Four Lectures delivered before the University of Oxford. By C. Daubeny, M.D., F.R.S., Professor of Botany and Rural Economy in the University of Oxford. 160 pp. 8vo.

ON RAILWAY ELECTRIC SIGNALLING. By Wm. Hy. Preece, C.E. 40 pp. Engravings. 8vo.

PAMPHLETS.

Natural History Museums. By the Rev. Leonard Jenyns, M.A., F.L.S., &c. 24 pp. 8vo. (Bath: Hayward.)

Reports by the Medical Officer of Health for the City of Glasgow. April and July, 1863; October, 1863; January, 1864; August, 1864. (Glasgow: Anderson.)

Report on the Health of Liverpool during the year 1864. By W. S. Trench, M.D. (Liverpool: Greenwood.)

Lodging-house Committee's Report, 1864 (Liverpool Health Committee). (Liverpool: McCorquodale.)

Commission des Logements Insalubres (Ville de Paris). Rapport Général sur les Travaux de la Commission pendant les Années 1852, 1853, 1854, 1855 et 1856. (Paris: C. de Mourgues Frères.)

Ditto ditto Années 1857-9.

Ditto ditto „ 1860-1.

Agricultural Education. By J. Chalmers Morton. (Read before the Royal Agricultural Society.)

Auriferous Quartz Mining. By Thomas Belt. Reprinted from the 'Mining Journal' newspaper. ('Mining Journal' Office.)

On the alleged Submarine Forests on the Shores of Liverpool Bay and the River Mersey. By Joseph Boult, F.R.I.B.A. (Liverpool: Brakell.)

The Declaration of Students of the Natural and Physical Sciences. (Simpkin, Marshall, & Co.)

On the Geology of Gloucestershire in reference to Agriculture and Rural Economy. By James Buckman, F.L.S., F.G.S. (Clowes & Sons.)

Catalogue of British Plants, including the Flowering Plants, and Characeæ: to which is appended a List of the Varieties of British Ferns. 4th edition. 40 pp. Post 8vo. (A. & C. Black.)

Remarks on the Health of European Soldiers in India. By H. Webb, Apothecary, Invalid Establishment, Bombay Army. (Printed for the Government at the Education Society's Press, Byculla.)

On the Wear and Tear of Steam Boilers. By F. A. Paget, Esq., C.E. (London: W. Trounce, Cursitor-street.)

A Lecture on Labour: its Influence and Achievements. By William Fairbairn, C.E., LL.D., F.R.S.

Additional Observations on the Drift-Deposits and more recent Gravels in the Neighbourhood of Manchester. (2 Pamphlets.) By E. Hull, B.A., F.G.S. (London: Taylor & Francis.)

List of the Diatomaclæ occurring in the Neighbourhood of Hull. By George Norman.

PERIODICALS, AND PROCEEDINGS OF SCIENTIFIC SOCIETIES.

The Geological Magazine. (Longmans.)

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